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UNIVERSITY OF ARIZONA ECLIPSE EXPEDITION.

Port Libertad, Mexico, Sept. 10. 1923.

By A. E. DOUGLASS.

Port Libertad is on the east side of the Gulf of California, about 60 miles north of Tituron Island, approximately 29° 55′ N. and 7^h 30^m 44^s W. The University of Arizona Eclipse Expedition, which occupied a station there, was equipped with a 5-inch lens of 39 feet focus, a telephoto combination of three inches aperture and fifteen feet equivalent focus, a visual three-inch lens of 52 inches focus and a "crossed" lens (nonachromatic) of 46 feet focus. The five-inch lens was mounted in a stationary position near the ground with a mirror below it sending a horizontal beam. The motion of the image was taken up by a carriage moved by clock-work, carrying a fourteen by seventeen-inch plate. Two photographs were obtained with this camera, one of which, an exposure of 32 seconds, accompanies this article. The diameter of the moon's image in the original negative is four and five-eighths inches.

Exposures were obtained in the smaller instruments of one, four, sixteen, and sixty-four seconds and a fifth exposure showed the sun just reappearing. The Corona may be traced in detail to twice the diameter of the sun away from its limb. The prominences are shown in detail in the 39-foot and the 15-foot cameras.

The plan in early spring was to go to some point near Hermosillo on the railroad south of Tucson. There one could reach with great convenience the center line of totality. But in July the rainy season proved so persistent that it seemed wise to change the station to a less convenient locality over on the coast of the Gulf. This proved very fortunate for the sky was clear in the greater part, but heavy thunderstorms hung over the mountains to the east of us during much of our stay.

The Corona was of the expected sunspot minimum type and the polar rays show well but not so conspicuously as in some of the recent eclipses. Eight stars were counted by one of the members of the party in a rapid survey of the heavens. The red chromospheric ring was noted; there was also a falling of the wind and lowering of temperature.

The party consisted of eight persons besides the writer. Mr. Godfrey Sykes and his two sons managed the 46-foot telescope but, owing to delay in reaching the site (from bad roads) and some interference by

clouds on the day before the eclipse, it was impossible to make some of the final adjustments and the results were not satisfactory. The small instruments of 52 inches and 15 feet focus were mounted on a temporary polar axis with a guiding telescope and were managed by five men. The timing was done by Mr. D. A. Hawkins, the guiding by Mr. William Done, both students in the University. Mr. Philips Brooks, and Mr. Edwin Knagge changed the plate holders in the two photographic telescopes. Mr. Ed. Bayless made the exposures. The writer was stationed inside the shelter and handled the plates of the 39-foot telescope and only saw the eclipse as it appeared through the photographic film.

Equipment was taken along for photographing shadow-bands and for photographing other items of interest, but no one could be spared to do this work. Lack of sufficient help was one of the difficulties experienced in occupying a somewhat inaccessible locality.

TOTAL SOLAR ECLIPSE OF SEPTEMBER 10, 1923. Observed From U. S. Navy Airplanes.

(Communicated by Captain E. T. Pollock, U. S. Navy, Superintendent U. S. Naval Observatory.)

In accordance with suggestions from Colonel John Millis, Corps of Engineers, U. S. A. (retired), of Cleveland, Ohio, and others, the Naval Observatory requested the Navy Department to have photographs of the eclipse of September 10, 1923, made by aviators from the Naval Air Station at San Diego, California. The Mexican Government very kindly granted permission for the American aviators to fly over Mexican territory. Stations were occupied at 6 points near the northern edge and 1 near the southern edge, and also at Point Loma and at La Jolla. The program called for photographs of the corona, photographs of the moon's shadow on the earth for locating the limits of the shadow, and photographs of the ground for the investigation of shadow bands.

The arrangements were in charge of Captain A. W. Marshall, U. S. Navy, Commander Aircraft Squadrons, Battle Fleet. His report and copies of the photographs secured have been received at the Naval Observatory. Unfortunately the weather conditions were unfavorable. Partly for that reason, and partly, doubtless, due to the inherent difficulties of making such observations from airplanes, the photographs do not seem to be of value scientifically.

The aviators took their stations at altitudes varying from 5,000 to 16,500 feet. They were all impressed with the beauty of the corona, and with the impressive onrush of the shadow which was described as resembling the approach of a dark thunder storm. For those near the edges of the shadow, an interval of about 10 seconds covered the period

PLATE XXXVIII.

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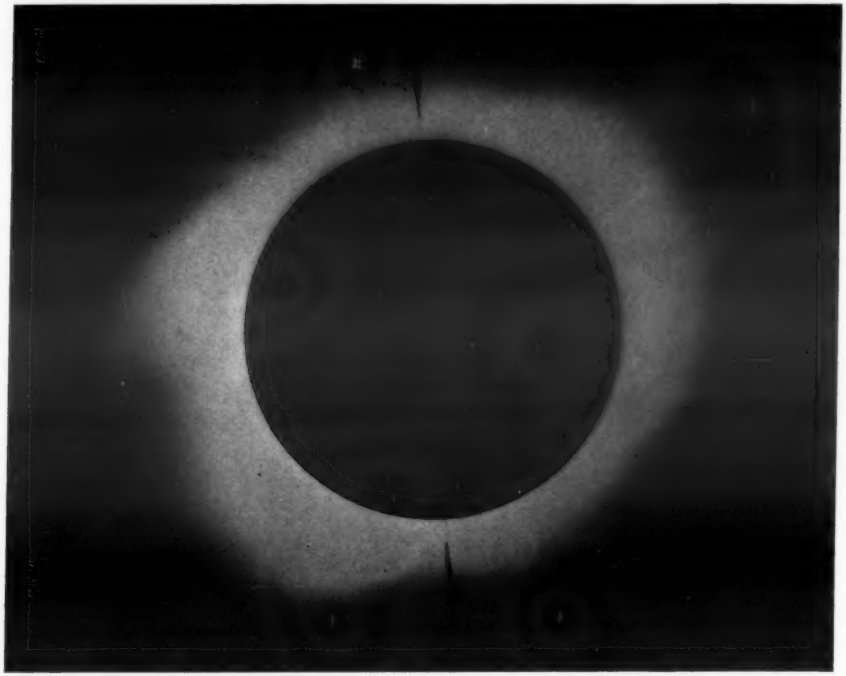

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PHOTOGRAPH OF THE SOLAR CORONA, SEPTEMBER 10, 1923.

Taken by the University of Arizona Expedition at Port Libertad, Mexico.

The photograph is reversed east and west because it was taken with a mirror in front of the lens.

from the first to last visibility of the approaching and departing shadow. Several observers noted a pinkish or reddish glow near the horizon and under the shadow. The shadow itself was described as being intensely black.

Lieutenant B. H. Wyatt, U. S. Navy, states that in his opinion "the use of airplanes to photograph the limits of the Moon's shadow on the earth could be accomplished under ideal conditions by the use of hypersensitized film and the K-3 type mapping camera, slowed down to give maximum exposure possible, or better results could be obtained by the use of moving picture cameras with full, wide opening and slowed down as much as possible. To attempt to photograph the shadow with a hand held camera and without the aid of hyper-sensitized film would be useless. The best position from which to photograph the shadow is just outside the edge of the shadow and looking from the light into the dark edge of the shadow as it passes by."

A complete report of the observations made by the Naval aviators will be included in Volume X, Appendix, Publications of the U. S. Naval Observatory, Second Series.

SOLAR ECLIPSE PHOTOGRAPHY.

A Forerunner of the Motion Picture Camera.

By MILLICENT TODD BINGHAM.

In the issue of *Science* for September 21, 1923, the following statement of Dr. E. E. Slosson occurs on page 223. "I have just seen something that has never been seen before—motion pictures of a solar eclipse."

This statement is so misleading that it is well to have the facts in the case brought once more to the attention of scientific readers. As will be pointed out later, although the first real motion picture of an eclipse was taken only in 1914, historic value attaches to early mechanical devices used before the motion picture camera was available for such a purpose.

The problem always has been to get the greatest possible number of photographs of a solar eclipse during the period of totality, especially just before and after the onset of totality when the corona first begins to appear. The solution of the problem required the invention years ago of automatic photographic controls and devices for mechanically shifting the sensitized plates, anticipating somewhat those later used in the development of the cinematograph. To Professor David Todd, for nearly forty years director of the observatory of Amherst College, is due the credit for being first, not only to define the mechanical problem as long ago as 1878, after his observation of the total solar eclipse in Texas in that year, but also to find its solution in developing

the earliest mechanisms for use in automatic eclipse photography. He had written in 1878 that the number of photographs obtainable by hand exposure during totality was "exceedingly meagre". But mechanical devices to increase the number of negatives taken during totality were first used by Professor Todd at Shirakawa during the eclipse of August 19, 1887, when he was in charge of the U. S. Eclipse Expedition to Japan. All the mechanical movements at that time were effected by levers and cords and pulleys directly connected.

The system was improved and very greatly enlarged for use during the eclipse of December 22, 1889. Professor Todd, in charge of the U. S. Government Scientific Expedition to West Africa in that year, described the apparatus as a "complete pneumatic system of automatic instruments." The photographic apparatus once "loaded" and set in motion took "entire care of itself from one end of totality to the other. The principle of the device was a pneumatic commutator which exercised perfect and automatic control over a score of telescopes and cameras for different purposes."

In Bulletin No. 12 (Dec. 31, 1889), printed on board the U. S. S. *Pensacola,* which took the expedition to West Africa, the apparatus is described as follows:

"A duplex polar axis eleven feet in length had been constructed.... ....driven by powerful clockwork of extreme precision. In all, there were twenty-three objectives and two mirrors, with their axes adjusted into parallelism. .....All this apparatus was operated automatically, by an adaptation of the pneumatic organ-valve system of Mr. Merritt Gally of New York. Exposing shutters were opened and closed, sensitized plates were exchanged for others as soon as exposed, and all the mechanical movements were accomplished with entire precision. Also, by employing an ordinary chronograph in conjunction with the valve system, the exact time of beginning and end of each exposure became a matter of accurate record. All this apparatus was brought into operation during the period of total eclipse, and over three hundred exposures were made in a period of 3 minutes and 10 seconds, but no photographs of the corona were secured, as the sun was completely obscured by clouds. However, the entire success of the pneumatic movements is a result of no little value in view of eclipse work of the future."*

In 1896 the apparatus was still further perfected and an electric system of control was substituted for the pneumatic, which was simpler than the latter both in construction and in operation. This was made use of by Professor Todd in Esashi, Japan, during the eclipse of August of that year. In all, twenty photographic instruments were worked into the automatic system "which but for an unhappy repetition of our ex-

*For more detailed description see *Nature*, Vol. XLI, p. 379, Feb. 20, 1890, The Total Eclipse, David Todd; also, Total Eclipses of the Sun, M. L. Todd, Roberts Bros., Boston, 1895, pp. 185 et seq.

perience in West Africa would have given us more than 400 exposures during a totality not to exceed 3 minutes."

A description of the most significant features of this apparatus can be read in Professor Todd's article on "Automatic Photography of the Corona" (*The Astrophysical Journal,* Vol. V, Jan.-May 1897. pp. 322-324). He says:

"Numerous devices for experimental shutters have been tried, but the type found best adapted to quick automatic control is a hollow rotary cylinder with a clear space cut through it, as shown in Plate XXIII. . . . Alternate quarter turns open and close it, and the rotation is under the precise, speedy, and effective control of an electric escapement permitting only a single quarter turn at each closing of the circuit. Below it and to the right is shown the plate movement. It is a four-sided barrel, whose revolution is effected by a long and powerful spiral spring wound round its journal. The 'fly' of a striker movement in an ordinary clock is connected with a pulley on the axis of the plate-barrel, and serves to make its working positive and yet not too rapid. This device is perhaps the best of our constructions; it keeps abundant power in proper check, and the detent-pins on the face of the barrel stop without any jar on meeting the escapement-pallets. Freedom from jar is a fundamental essential in all the automatic movements when several instruments are mounted on the same polar axis; for the tremor of the shutter and plate movement of one might ruin the definition of another where an exposure is in progress. The plates are slipped into holders strung together in a jointed but inextensible chain, which passes over the four-sided plate drum. A long chain of plates of any desired size is easily within the capacity of this construction. The heaviest loads thrown upon instruments of this type were a chain of 24 plates 8 x 10 inches, and 150 plates 2 x 2½ inches. Both showed themselves capable of perfect working. The particular movement shown in the illustration handled 36 plates 4 x 5 inches. The large diagonal slide was constructed for automatic working by an armature as figured on its right side, gravity furnishing the power; and two orthochromatic screens, one orange and the other neutral tint, were mounted in the two apertures, and permitted to descend between barrel and shutter at the instant required. At first the plate drum and shutter were both moved independently by circuits from the commutator; but in our final instruments a contact spring was attached to each shutter, and an independent circuit through it controlled the shifting of the plates."

A similar set of mechanical cords and pulleys was used in Singkep, Dutch East Indies, in May, 1901, but for the fourth time clouds obscured the sun during the six minutes of totality.

The successful operation of his machine was not enough. Professor Todd determined to persevere until he should secure actual photographs of the corona by the automatic method. Accordingly in August, 1905, though less elaborately equipped, he went to Tripoli, Barbary, where skies were sure to be clear. With "a three and one-half inch

Goerz doublet of thirty-three and one-half inches focus, attached to one of the automatic movements used on my previous expeditions," he says, "I secured 63 fine pictures of the corona during the 186 seconds of totality." (*Science*, N. S., XXIII, No. 586, 1906, Amherst Eclipse Expedition to Tripoli, David Todd.)

Meanwhile, other devices of a somewhat similar nature were used many years ago by other astronomers—by Dr. Campbell, for instance, at least as early as 1900 in Georgia, if not in Jeur, India, in 1898. In order to record all the stages of the genesis and decay of the flash spectrum, he gave a regular movement (continuous) to the plate-holder of the apparatus, so that the slowly moving plate caught all the stages of the phenomenon, showing the solar spectrum before the eclipse, and then the appearance and dying out of the bright lines of the flash. In his earlier instruments of this sort he employed clock-work to move the plate; in the later models he used a carefully made clepsydra cylinder with an accurately calibrated valve to regulate the speed of movement of the plate.

Again, Becker, in 1905, (*Lond. R. S. Proc.* **77** A, 97) used an apparatus regulated by a pendulum to give automatically ten exposures of varying lengths. Wolfer, at the same eclipse, had 12 plates arranged on a drum in his camera, quite like a moving-picture mechanism (*Astr. Mitt.*, Nr. 97).

The essential difference between these ingenious early inventions and a motion-picture film is that the latter is a device for taking a great many pictures of a phenomenon on a small linear scale, a close parallel to Professor Todd's automatic arrangements for taking a considerable number of pictures of scientific value during an eclipse. But the motion picture film is made with the main purpose of being reproduced in the rapid serial succession of its pictures in order to show the eye the progress of the phenomenon.

Automatic photography would have been further perfected by Professor Todd during the eclipse of August, 1914, when he went to observe it in Russia, had not war interfered. His instruments did not arrive on account of delays incident to the outbreak of the war, until the night before the eclipse, too late to make use of them (*Nature*, Oct. 29, 1914). But he writes (*Amer. J. of Sci.*, **38**, No. 228, 1914, The Amherst Eclipse Expedition): "Dr. E. Nordenmark got the eclipse with a cinematograph at Solleftea, Sweden, in a perfectly clear sky. This film contains many hundred impressions of the corona at a speed of 6 to the second, and shows also a fine coronal ring on all exposures just before and after totality. This first complete success of the cinematograph is of great interest as indicating the availability of automatic photography for the portrayal of the swift development of a total eclipse."

Thus the first rudimentary plate-chain operated by cords and pulleys in August, 1887, was superseded after twenty-seven years for the first time by modern motion picture apparatus in August, 1914.

While Dr. Nordenmark's film was probably the first real motion picture of a total solar eclipse, many have been taken since that date. In 1918, for example, Dr. Frost used two motion picture cameras, one to record the stages of the flash spectrum and the other for the eclipse as a whole (*Pop. Astr.* **26**, 461).

Again, a successful motion-picture was made of the 1922 eclipse at Wollal, Australia. It is referred to in *Observatory*, May 1923, p. 170, and an account taken from *Nature* can be found in *Science*, **57**, 656, June, 1923. Thus the statement claiming priority for the film made this year is certainly in error.

LOUIS BELL.

By EDWARD S. KING.

Dr. Louis Bell, a loyal and enthusiastic member of the American Astronomical Society, passed away on June 14, 1923, while still in an active career of achievement. All his work is noteworthy, whether in electricity, illumination, or optics, but astronomy seemed to possess his soul. To work with the stars was for him a solace and a joy.

Few men are the product of their ancestry more than was Louis Bell. His staunch immigrant ancestor, John Bell, crossed the sea two hundred years ago "to cast his lot with the granite of New Hampshire." Tracing back his Scottish kinsmen from the north of Ireland to Matthew Bell, born about 1650 in Kirkconnell, Scotland, the Bells are found among those who "Kepit the marches in the fields of eld," with their arms hung in the great hall at Abbotsford, in the long line of border families, whose history was so familiar to Sir Walter Scott.

The name was originally Le Bel, when the first of the line came over with William the Conqueror in 1066. Drifting northward, the Bells became established in Scotland, and later raided the English and were raided in turn, in the wild border forays, when the "people knew no liege save the sword." Indeed, the sandstone door posts of the gray and ivy covered Blacket House, with "W. B. 1404" cut on the lintel, still shows the marks where successive generations of Bells sharpened scythes or swords as the exigencies of the time required. It was a period of clannish feuds, romantic love, and sudden death. An epitaph of 1510 bears witness to the strenuous life and the successful longevity of one of the Bells of Blacket House:

"Here lyeth W. Bell, of his age eighty yheres.
Here bluidy Bell, baith skin and bane,
Lies quietly still aneath this stane,
He was a stark moss-trooper kent,
As ever drave about o'er bent,
He hynt ye Lockwood tower and hall,
And dang ye lady o'er ye wall,

For whilk ye Johnstone, stout and wight,
Set Blacket a' in low by night,
While cried a voice, as if frae Hell,
Haste, open ye gates for Bluidy Bell."

These doughty Bells were the ancestors also of Dr. Joseph Bell, a distinguished professor of surgery in Edinburgh University in recent years, who was a teacher of Sir Conan Doyle, and the prototype of "Sherlock Holmes."

The Bells of the later generations were more pacific, but were still men of affairs. Members of the family who emigrated to America have furnished U. S. Senators, Congressional representatives, a Speaker of the House, a U. S. Chief Justice, a Secretary of War, a presidential candidate, and a Governor of Texas. But it was in the Granite State where the descendants of John Bell held sway as amid the rocky fastnesses of old Scotland. They furnished that state with three governors, one of whom, Samuel Dana Bell, was said to have "carried New Hampshire in his vest pocket" for at least two decades. As U. S. Senator, he was most intimate with Daniel Webster, and was in conference with him the entire night previous to Webster's famous reply to Hayne.

Samuel Dana Bell was Louis Bell's grandfather, and in his old home, a big colonial house on a commanding hill in the town of Chester, N. H., Louis was born December 5, 1864. By a strange reversion, history harked back to the wild-riding days on the Scottish border, and so the life of Louis came early under the tragedies of civil war. His father, General Louis Bell, was killed January 15, 1865, at the assault on Fort Fisher, and six months later his mother died literally of a broken heart.

Here in the quiet old homestead the boy grew up, with the grandmother more fond than wise in indulgence, with "old Hannah" for forty years in the family and nurse to his father before him, and dearest of all, with the little sister Marian four years older than himself. The tragedy of life rested heavily upon him. His father was his hero. He read and re-read all his letters from the fields of battle, and from them received inspiration. General Bell was a remarkable man. While a student at Brown University he attained high rank, especially in chemistry, knowledge which he applied effectively in military service. With the advent of civil war he responded immediately to the first call for volunteers. His commanding physique and his high standard of military proficiency made him an ideal officer. His strict though reasonable discipline endeared him to his men. Had he thought only of himself and family, he would not have been in that last fatal charge, just on the eve of a visit home to the young wife and new-born child. He refused to avail himself of his furlough, while his men were encountering danger. They had been faithful to him, and he died leading them gallantly. This was the heritage to his little son, which markedly shaped the boy's life.

Louis' scientific imagination found early expression. An uncle tells

PLATE XXXIX.

DR. LOUIS BELL.
1864-1923.

of finding the little fellow, still in kilts, enjoying a perfectly good pump he had constructed with a tin can and other adjuncts as simple,—a fitting prelude to his forty or more patents of later life. The home was provided with a good-sized library, and the boy read it eagerly, especially the books on chemistry, the favorite study of his father. He was always interested in nature, and when he asked about a butterfly, the library afforded colored prints with the Latin names. About this time he obtained his intimate knowledge of the Bible, often being given his choice of going to church or memorizing as many verses as he was years old. When teased at private school as the smallest boy and with reddish hair, the hereditary hue handed down from his Scottish forbears, he found enjoyment in his Virgil in the seclusion of a graveyard. His childhood was that of a lonely sensitive boy, living in the memories of the past, and dreams of the future.

Sent to Phillips Exeter, school life was brightened for him by the presence of his sister at the neighboring girls' academy. She was very dear to him, and when she died at the age of twenty-one, it was a grief to which he was never reconciled. He could never trust himself to speak of her. It was ever black tragedy to him. At Dartmouth, he began to wield a trenchant pen as editor of the college paper. Fearless as always, he wrote too plainly of the president, who believed in the total damnation of unbaptized babes. He was "rusticated." Unrepentant, he appeared at the New York home of his uncle and guardian, editor of the N. Y. Journal of Commerce. After passing his three months of exile in reading at the Astor Library, and hearing good music at every opportunity, as he ever did throughout his life, he returned to college and passed in a most brilliant paper, which won even from reluctant faculty members a unanimous honorable mention. An escapade of his college days introduced discord into the Chapel service at one time, when he and two other students mixed the organ pipes. The secret was well kept until years afterward, when they were secure from Olympic wrath. His happiest memories of college were, perhaps, of two joyous summer vacations, when left in charge of the observatory he could use the instruments as much as he desired. Here was implanted his love of astronomy, which grew ever stronger as the years passed.

After taking his degree of A. B. in 1884, Bell remained a year in post-graduate study at Dartmouth. Then he went to Johns Hopkins University, where in 1888 he received his Ph. D. in physics, studying under and with Prof. Henry A. Rowland. At the end of his course, when only 23 years of age, he was sent to Birmingham, England, to present before the British Association for the Advancement of Science the results of their joint research. Here began that English appreciation of his ability, which retained him for years as Vice-President of the Illuminating Society of London. Going directly to Purdue University as a member of the faculty, Dr. Bell organized the department of electrical engineering in that institution on a sound and efficient basis.

In 1890, he became editor of the Electrical World and in two years had firmly established its position. In 1893, as chief engineer of the newly-organized power transmission department of the General Electric Co., he designed and installed at Redlands, California, the first three-phase transmission plant for general service, which was almost miraculous in its unexampled efficiency. It is not possible to recount here his numerous achievements in electrical and engineering problems. His books, "Electric Power Transmission" (1897), and "Art of Illumination" (1902), were the earliest standard treatises on these subjects published in America.

On December 3, 1893, he was married to Sarah G. Hemenway of Somerville, Mass., who with a son Louis and two granddaughters, survives him. In 1895 Dr. Bell came to Boston, and opened his office as consulting engineer, which he kept until his death. In addition to his professional work he lectured at Harvard University, the Harvard Medical School, and the Massachusetts Institute of Technology. His honors and affiliations were many. He was a fellow of the American Academy of Arts and Sciences, and served on the Rumford Medal Committee; important papers of his are published in the Proceedings of the Academy. Many societies in engineering sciences were proud of him. He was a member or chairman of many national and international committees or commissions. But always he derived unqualified satisfaction and enjoyment from his association with the American Astronomical Society.

Bell was a clear and forceful writer; aggressive at times, for he never was half-hearted in any cause which he championed. There was a humor and a graphic touch, all his own, which held attention even to very technical subjects. Among his astronomical papers may be mentioned "Star colors, a study in physiological optics," "The physical interpretation of albedo" with special reference to Saturn, "Ghosts and oculars" and "The early evolution of the reflector." While recovering from a severe attack of pneumonia in 1922, he wrote his book "The Telescope," destined to remain a classic for both professional and amateur astronomers.

Dr. Bell came frequently to the Harvard Observatory. Some of the pleasantest hours of the writer's life have been those spent with him in a little upper room, where we discussed many problems scientific or otherwise. He was ever helpful in suggestion. By his advice and assistance, we have at Harvard successfully protected the silvered surfaces of our 24-inch reflectors from atmospheric tarnish by coating them with a special lacquer. His interest in astronomy continually increased. During the last year of his life he was one of the Board of Visitors to the Observatory. He addressed the autumn meeting of the Variable Star Association on the effects of color-blindness in astronomical observations. His latest research was in the breaking down of carbon into atoms of helium in the powerful Sperry searchlight. He paid a notable compliment to astronomy in presenting the first report

of this far-reaching achievement to the Amercian Astronomical Society at its Cambridge meeting. Absorption in astronomy was for him a release from engineering problems. In times of stress he turned instinctively to astronomical reading and research as a most congenial occupation. At the time of his death he was working on certain sequences of stars for use by astronomers in estimating telescopic efficiency and atmospheric clarity.

Following the tradition of the family, Bell was a good shot. He began as a child when he had to use both hands to hold his father's heavy army revolver to shoot at a target. Later he became amateur champion for America with the revolver, and was also a member of the American team which won against the French in an international match. He was no less skillful with the rifle, and for many years found recreation for Saturday afternoons on the Walnut Hill range.

In times of war his services were at the command of the government. In 1898 he was in charge of the electrical coast defense on the Atlantic seaboard. In the recent war, he was a member of the Advisory Committee on the Council of National Defense. In this connection he developed a working system of invisible signalling by ultra-violet light, spending prodigally of his strength and means. The device would have proved of incalculable value, had the war continued.

Dr. Bell had an intense love of nature. Behind the grounds of his beautiful home on West Newton Hill was a bit of woodland with winding paths, cunningly laid out to increase its apparent size. Here with loving care he had naturalized many of New England's rare wild flowers. He had learned the charm of rural surroundings in his childhood, and was able to impart these joys, as he watched plants or birds, or collected butterflies with his boy.

For some years he had battled with ill-health, and with seeming success until his recent attack of pneumonia. From that time his strength gradually failed. Yet with indomitable will, he kept on so that few, except the brave wife who devoted herself to his care, suspected how desperate was his condition. The fighting spirit of his dauntless Scottish ancestors sustained him. Although very weak at the last, his mental resources were as keen as those of a young man seething with ideas. Within a month of his death he formulated plans for observing the total solar eclipse of this year. It had been his proposition that a government boat should convey the astronomers of the Atlantic coast to and from the eclipse, and he had hoped against hope that he might go. He was frankly eager to attend the Commencement exercises at Dartmouth, his Alma Mater, when the honorary degree of Doctor of Science was to be given him. Alas! it was not to be. The degree was awarded posthumously five days after his death.

The varied interests of Louis Bell in science, literature, and art made him a delightful conversationalist. His fund of knowledge of men and things seemed inexhaustible. His sense of humor was unfailing, but his real charm to those who knew him was the open, man to man, re-

sponsiveness of his heart, and the almost boyish enthusiasm which he put into life. Constant in friendship, holding firm his convictions, a courteous gentleman ever, generous in his judgments, his was a personality which never can be lost.

NOTES FROM "THE STONE OF THE SUN AND THE FIRST CHAPTER OF THE HISTORY OF MEXICO."

By LEAH B. ALLEN.

The monument known as the "Stone of the Sun" or "Aztec Calendar Stone," a monolith 12 feet in diameter, was found under the pavement of the Plaza Principal in the City of Mexico in 1790 and is now in the National Museum of that city. An excellent copy of its carved surface is in the National Museum, Washington. Professor Frederick Starr's translation of "The Stone of the Sun and the First Chapter of the History of Mexico" by Señor Enrique Palacios gives in English a detailed description of the engraving and a critical account of several hypotheses of its meaning. The translation was published in 1921 by the University of Chicago Press as Bulletin VI of the Department of Anthropology. The chronology of the Aztecs and their predecessors the Toltecs, being based on a combination of the movements of the Sun and Venus, is strikingly different from ours and especially attractive to lovers of Venus. Señor Palacios says the monument should be called "Stone of the Sun and Venus." The following notes are a brief summary of the interpretations which seem most plausible to him.

The synodic period of Venus is 583.921 days. $5 \times 584 = 8 \times 365$. Thus Venus and the Sun came into nearly the same configuration on the same date every eight Aztec years, an event which the Aztecs celebrated with a festival. Thirteen such cycles, 65 synodic revolutions of Venus, equaling approximately 104 years of 365 days, served as our century. The Aztecs named the days through 20, but numbered them only through 13. Therefore as the names were repeated, they were accompanied by different numerals. As 52×365 is the least common multiple of 13, 20, and 365, each year in a series of 52 began with a different combination of name and numeral and could be designated by such a combination. Dates expressed in this way are perplexing, as a year may be any one of several separated by a multiple of 52. The interval of 52 made a "Bundle of Years" at the end of which all fires were extinguished and the priests ceremoniously built the "New Fire"

on the altar. As 584 divided by 20 leaves a remainder of 4, each Venus period began four days later than the previous one and repeated the same series of names every 5 revolutions. These five day-names were accompanied by different numbers through 65 synodic revolutions, 13×5, the equivalent of 104 years. So every 104 Aztec years the Venus and solar cycles began together. There was a discrepancy in the date at which the same configuration would be seen, due to the fact that the synodic period of Venus lacks $0^d.079$ of being 584 days. Longer intervals were marked by multiplying the 65 Venus periods or 104 years by 4, considering 260 synodic revolutions equivalent to 416 years. $260 \times 483.921 = 416 \times 365 - 20$. Therefore a certain configuration of Venus and the Sun would occur exactly again on the same day-name after 416 years minus 20 days.

The central figure of the sculpture is an aged face bearing the glyph of the Sun god. The tongue is protruding, symbolic of light. Surrounding this in concentric circles are symbols of the seasons, the names of the 20 days, numerals, glyphs of the Sun and of Venus, and two encircling serpents highly ornamented with numerals. The serpents hold in their open jaws two heads facing each other. One of these is believed to be that of the Sun god; the other, that of Quetzalcóatl, identified with Venus. Señor Palacios has found the cycles of 52 and 104 years each expressed in three ways; the one of 416, in five. For instance, 260 small dots arranged in groups of 5 suggest the cycle of 5 Venus periods; the total, an age of 416 years. A solar glyph is repeated 104 times; the bodies of the serpents are marked with bands of 4 short rays; 52 bands in each serpent, 416 rays. Palacios says: "The purpose was the engraving of a number, not of an ornament."

The year-name, 13-Acatl, is carved prominently in the outermost circle with the tails of the serpents pointing like arrows to it. That was the designation of the year 699 A. D., the year in which, according to evidence cited by Palacios, a Toltec monarch called an assembly of astronomers to revise the calendar. It is possible that the stone was designed at that time to record the event and the calendar. But the year 1323 in which the Aztecs, having superseded the Toltecs, founded Tenochtitlan (Mexico City) was also 13-Acatl. So too was 1479, the year in which the Aztecs celebrated the completion of the grand cycle of 416 years since their migration from an earlier home. Palacios has given the evidence to support each of these dates and the hypothesis that it was carved in 1479 to commemorate all three of the anniversaries.

THIRTIETH MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY.

(Continued from page 579.)

CONDITIONS APPARENTLY EXISTING IN THE SOLAR CORONA.

By W. W. Campbell.

The chief purpose of eclipse expeditions is to study the sun's corona, that appendage of our sun which is visible only at times of total solar eclipse. The astronomer has good and definite reasons for making large expenditures of time, energy and money to observe total eclipses. The corona is a part of the sun, and we cannot say that we understand the sun until we understand all parts of it. Our sun is the only one of the hundreds of millions of stars in our stellar system near enough to us to let us study it in any detail. A growing knowledge of our own sun is enabling us to get a better understanding of the stars in general.

Total eclipses occur somewhere on the earth about once in 22 months on the average, but many occur on the sea, and others find clouded skies. The astronomer who devotes his entire life to observing total solar eclipses can scarcely expect to have more than one hour in which to view or photograph the corona.

It has been found that the general form of the corona depends upon the sun-spot conditions: when sun-spots are in maximum number the corona is circular in form; when the spots are in minimum number, the corona is characterized by weakness near the north and south poles of the sun, and by streamers of great length stretching out to the east and west. The precise relationship of sun-spot activity to coronal form is now known, and the reason for any dependence of the one upon the other is totally unknown. Large-scale photographs of the corona have been obtained at epochs of sun-spot maximum and minimum, and at epochs on the descending branch of the sun-spot curve, but they are lacking for epochs on the ascending branch. The eclipse of January, 1925, given clear skies, should remove the deficiency in part.

The great coronal streamers of spot minimum do not proceed from the sun-spot zones, but their bases lie in general between solar latitudes 30° and 60°, both north and south of the sun's equator; in other words the centers of these streamers' bases are near latitudes +45° and —45°. It cannot be said that eclipse observations have given evidence that coronal streamers, prominences and sun-spots are closely related phenomena in the geometrical sense; but the indications for some connection between streamers and prominences are clearly stronger than for streamers and sun-spots.

It has been thought by most astronomers, up to the present year, that the forms of many coronal streamers, especially those near the sun's

poles, are controlled by the sun's general magnetic field; but studies of large-scale coronal photographs obtained by the Lick Observatory at the eclipses of 1898, 1900, 1901, 1905 and 1922 seem to show that this cannot be the case, at least for the polar streamers. The position angle of the axis of symmetry of the coronal streamers in each of the five "minimum" coronas is in good accord with the position angle of the sun's axis of rotation, the average discrepancy being less than one degree of arc. The average difference between the position angles of the axis of polar streamer symmetry and the position angles of the sun's magnetic axis appears to be as great as four or five degrees.

The spectrographic and polarigraphic observations of the coronal light show clearly that the coronal materials close to the sun are in part gaseous and in part solid or liquid particles shining chiefly because they are heated to incandescence, and that the middle and outer corona is composed of gas molecules or minute solid particles, one or both, shining by virtue of the sunlight which falls upon them. The spectrum of the middle and outer corona is the same as that of the sun itself, except that the absorption lines on the coronal spectrograms are wider and less clearly defined than the same lines are on sky spectrograms secured with the same spectrographs, the same slit widths and equally effective exposures, as Messrs. Moore and Campbell noted in 1918 and 1922.

Dr. Moore has measured the positions of ten Fraunhofer lines on a 1922 coronal spectrogram, in search of Doppler-Fizeau effects, for points 30′ east of the sun's east limb and 30′ west of the sun's west limb. The results are in good accord for the ten lines, and the average velocity observed is 26 km per sec., recession. As this is an integrated effect, and light scattered by minute particles lying in the half of the coronal structure nearer the earth would be less effective than light proceeding from particles in the farther half, the correct interpretation of the observation seems to be in favor of motion outward in the corona. The general appearance of the coronal streamers is clearly in favor of motion outward from the sun.

Photographs of the corona (Miller's results on coronal hoods over the prominences) and of its spectrum secured in 1918 and last year in Australia, respectively, furnish evidence in support of the theory that the coronal materials are traveling outward from the sun; that they are being driven away from the sun, probably never to return to it. It is quite in line with possibilities that the sun is gradually losing mass in this manner, but so slowly that millions of years would be required to produce effects appreciable to a terrestrial observer. There are good reasons for suspecting that the stars in general are slowly losing mass. Astronomers would like to know if all the stars have coronas, their coronal materials representing gradual losses of mass.

DENSITY DISTRIBUTION IN THE PHOTOGRAPHIC IMAGES OF ELLIPTICAL NEBULAE.

By Edwin Hubble.

The term elliptical is used to designate the wholly amorphous non-galactic nebulae which show no traces of spiral structure. The chief characteristcs are: (1) rotational symmetry about the dominating non-stellar nuclei and (2) a steady decrease in luminosity from the nuclei outward. The boundaries are undefined and dimensions of the photographic images of individual objects made under standard conditions are functions of the exposure times.

Density curves have been constructed for twenty of these nebulae from measures of series of images on single plates with a Koch self-registering microphotometer, the sensitive element of which is a thermocouple constructed by Pettit and Nicholson. The curves are similar and can be closely represented over the range in density for which the Herter and Driffel curve is a straight line, by the formula $D = D_0 - 2 \log (r/a + 1)$ where D is the density of the photographic image, D_0 is the central or nuclear density, r is the distance from the nucleus, and a is a constant peculiar to an individual nebula and to the particular diameter along which the density is measured. For a given object a is maximum along the major axis and minimum along the minor axis. The ratio of these values measures the eccentricity of figure of the image.

A mean curve representing thirty individual curves for twenty separate nebulae has been constructed by plotting r/a against D, and adjusting to a mean central density. Residuals over the well defined portion of this curve average less than one per cent of the range from free film to total blackening, and over the entire curve average less than 2 per cent. The total range in density for this curve is about 2.00, representing a range in luminosity from 1 to 100.

Since D represents the log of the luminosity, the distribution of luminosity in the projected images of these nebulae can be represented by

$$L = \frac{L_0}{(r/a + 1)^2}$$

Density curves for four nebulae have been constructed from images made on Iso plates through visual color filters. For three of these the photographic and photovisual curves are strictly parallel. For N.G.C. 221 (M 32) the photovisual curves are steeper than the photographic, indicating a color effect in the sense that the nucleus is redder than the outer regions.

NOTE ON THE RADIAL VELOCITY CURVE OF ζ GEMINORUM.

By T. S. Jacobsen.

Nineteen spectrograms of ζ Geminorum were secured with the new Mills spectrograph in the interval between March 5 and May 15, 1923. When the resulting radial velocities were plotted it was found that, within the errors of measure, they fitted the curve determined by Campbell on the basis of 44 spectrograms secured by him in 1898-1900. The *period* producing the best agreement between the two series of observations is $10^d.15258$. This differs appreciably from the best modern periods determined from the light-curve of the star, Chandler's being $10^d.15382$ and Guthnick's $10^d.15457$. Further photometric and spectrographic measures are obviously desirable.

RADIAL VELOCITY MEASUREMENTS OF THE SPECTRUM OF o CETI.

By Alfred H. Joy.

The spectrum of o Ceti undergoes many striking changes during its period of light variation of 330 days. Several of these phenomena have been reported upon in previous notes by Adams and Joy. The study of the velocity measurements on 85 spectrograms taken with the 60- and 100-inch reflectors on Mt. Wilson throughout the last seven cycles makes it possible now to point out the effect upon the position of both bright and dark lines of the changes which take place in or about the star during its periodic increase and decrease in brightness.

o Ceti has been observed previously by Campbell, Stebbins, Küstner and Plaskett, and radial velocities deduced for the observations made near the maximum of light but no attempt has heretofore been made to carry the observations through the minimum phase. The agreement of the present series with earlier observations, many of which were made with three prisms, is satisfactory so far as they go, the trend of the velocity variation being indicated if not actually confirmed.

The Mount Wilson plates were all taken with spectrographs of one prism and in most cases with a camera of 18 inches. When the star was fainter than 9th magnitude a 7-inch camera was used. The plates have been taken by various observers; all have been measured with a Gaertner machine at least twice and many by several different measurers.

Dark Lines. The absorption lines used are in general the low temperature lines of various metals. These lines are numerous at maximum but at minimum only a few of the most persistent lines of chromium, calcium, titanium, and vanadium remain. The velocity observations are weighted and grouped to form normal places of nearly equal weight. The resulting velocity-curve takes the form of the light-curve with

maximum velocity of recession at maximum of light. The shape of this curve can be described in terms of the elements of a binary orbit. These have been determined approximately.

$$\begin{aligned} P &= 331 \text{ days} \\ K &= 6.4 \text{ km/sec.} \\ \gamma &= +57.8 \text{ km/sec.} \\ \omega &= 267^\circ \\ e &= 0.17 \\ T &= 267 \text{ days} \\ a \sin i &= 28{,}000{,}000 \text{ km} \end{aligned}$$

Although the range is not large there can be no doubt that the variation is real. It is apparent that elements may be found which will satisfy the observations with a high degree of accuracy, yet we hesitate to conclude that there are two bodies involved until all possible causes which might be connected with the variation of light have been considered. The velocity-curve is the reverse of that of a Cepheid variable where the greatest negative velocity occurs at maximum of light.

Bright Lines. The series of sharp bright hydrogen lines appear soon after the star begins to increase in brightness and disappears shortly before minimum is reached. Their maximum brightness is reached a few days after the maximum of light. As the star diminishes in brightness there appear a number of bright lines similar in character to the hydrogen lines. These lines have been found to give the same displacements as the hydrogen lines if they are assumed to be the low temperature lines of iron, silicon, and magnesium. Eight of the most persistent of these lines have been chosen to give a velocity-curve for the bright lines. The lines used are Hδ and Hγ of hydrogen; 4202, 4216, 4291, 4308 and 4376 of iron; and 4571 of magnesium. The curve formed from weighted normal places shows a minimum at the phase when the dark line curve is crossing the γ-axis at decreasing light and rises abruptly to a maximum at minimum of light so that at the star's minimum phase there is no difference between velocities measured from dark and bright lines. Curves have been drawn for each of the bright lines separately and it is found that all alike follow the course of the mean curve.

An important conclusion and one which may be fundamental in case similar variations of velocity are found in other variable stars of this class, is that so far as can be judged from a study of a considerable number of spectrograms taken throughout several cycles, the velocity changes repeat themselves more consistently than the light changes. It is possible that minimum brightness is a more normal condition than maximum since at that time the emission lines are not displaced with respect to the absorption lines.

The bearing of the velocities upon a pulsation theory presents some interesting features which may be possible of solution but they should be considered in connection with the general physical conditions involved. We are here dealing with a giant M-type star which is un-

doubtedly of very great size and very low density. If the velocities represent actual contraction and expansion of the star, the change in the dimensions must be enormous on account of the length of time involved, but it may well be that the percentage change in size is no greater than in the case of the Cepheid variables of much earlier spectral type and smaller diameter.

REGULARITIES IN THE ARC SPECTRUM OF ZIRCONIUM.

By C. C. Kiess and Harriet Knudsen Kiess.

The element zirconium of atomic number 40 is a member of column IV of the periodic classification and follows next after titanium of atomic number 22. We have already called attention to regularities in the arc spectrum of titanium (*Jour. Wash. Acad. Sci;* **13**, 270, 1923) and in this note we wish to announce that we have found regularities of the same type in the arc spectrum of zirconium. Groups of lines related by recurring constant wave-number differences are known as multiplets. In the spectrum of zirconium the greatest number of lines found in any multiplet is 13 and they are linked together by the wave-number differences 153.0, 225.8, 291.6, and 348.5.

The following group of lines will serve as an illustration:

						4166.36(5)	*348.47*	4227.74(7)
						413.03		*413.00*
				4187.55(4)	*291.58*	4239.31(6)	*348.44*	4302.87(6)
				304.76		*304.72*		
		4201.44(4)	*225.80*	4241.68(5)	*291.54*	4294.79(5)		
		223.13		*223.08*				
4213.84(5)	*153.10*	4241.20(5)	*225.75*	4282.20(5)				
148.31		*148.11*						
4240.34(5)	*152.90*	4268.01(4)						

The numbers in parentheses following the wave-lengths are the intensities of the lines, and the italicized numbers are the wave-number differences which separate them.

Similar groups of lines have been found throughout the spectrum from the violet to the infra-red. The lines of several groups are cited by Rowland as occurring in the absorption spectrum of the sun. We expect to publish shortly a detailed report of the investigation.

PROGRESS WITH COLOR INDEX APPARATUS.

By Edward S. King.

The apparatus for photographing fields of stars in blue and yellow light simultaneously on the same plate was described in a paper presented at the twenty-eighth meeting of the Society.

During the past year two important improvements have been made. Through the kindness of Dr. Mees of the Eastman Research Labora-

tory in furnishing a suitable dye, I am now able to purify the portion of light producing the blue image from any admixture of yellow, which hitherto was present. The two images, the blue and the yellow, are thus rendered more closely complementary.

For obtaining a scale of magnitudes, I have added a wire diffraction grating, placed in front. The grating is oriented to make the wires parallel with the throw of the small achromatic prism, which separates the blue from the yellow image. Stars, photographed in this way, show each of their two images expanded into a diffraction series without superposition. The grating is of polished steel drill rods about a millimeter thick, with spacing equal to their thickness. The diffraction images of the first order, compared with the central images, give the scale value of a magnitude. Possibly it may be better to vary the elements of the grating to increase the interval. The advantage of the grating over the method by apertures is that it assures the same conditions for all the images. Any slight change in the sky or in the rate of the driving clock is eliminated.

With this apparatus a single exposure will determine the color indices of stars, over a field of considerable area, not only qualitatively but quantitatively.

OBSERVATIONS OF THE LIGHT OF THE NEW STAR IN THE SPIRAL NEBULA N. G. C. 5236 (MESSIER 83).

By C. O. Lampland.

An account of the discovery of the new star in the spiral nebula N. G. C. 5236 has been published (*Publ. A. S. P.*, **35**, 166, 1923). An attempt was made in the present instance to obtain observational material for the determination of a light curve of this star. Two or more photographs were made on every clear night, and generally visual comparisons were also made of the brightness of the star referred to neighboring stars. An extensive series of visual magnitude estimates of the star was carried out by Mr. E. C. Slipher, with the 24-inch Lowell refractor, but his observations have not yet been reduced.

The values of the magnitudes given are provisional. Preliminary estimates of the brightness of the star have been made on photographs taken with the 40-inch Lowell reflector, and are based on comparisons with several plates of Harvard standard regions exposed at different times during the course of the work. At the time of discovery it was hoped that the star might have been caught before its rise to maximum light, but it was soon found that this phase must have occurred earlier, if temporary stars in spirals undergo light changes similar to those observed for galactic novae. During the first ten days after discovery the light of the star was comparatively constant, the variations in the estimated brightness on different nights being of the order of a tenth

of a magnitude. The star during this interval was very nearly magnitude 14. Between May 15 and June 4 the light fell off quite uniformly from magnitude 14 to about magnitude 15.5. From June 4 until June 17 it remained in the neighborhood of magnitude 15.5. From June 17 until July 3 the light diminished to magnitude 15.7.

THE SPECTRAL PARALLAXES OF VISUAL DOUBLE STARS.

By Frederick C. Leonard.

In a paper entitled "An Investigation of the Spectra of Visual Double Stars" (*Lick Observatory Bulletin*, **10**, 169-94, 1923), a method for determining the hypothetical spectral parallaxes of double stars was outlined. In that paper the statement was made that it is possible to form a general estimate of the absolute magnitudes of the components of a double star from the positions which the system occupies on the several charts accompanying the paper—to decide at least whether the pair is a giant or a dwarf; conversely, if the spectral classes and the inequality in magnitude between the components, but not their parallax, be known, from the position which the double star would normally assume on Fig. 4 (*ibid.*, p. 189), a fair approximation to the absolute magnitudes of its components, and hence an hypothetical value of the parallax of the system, may be derived.

This method has been applied to assign what is here termed the *spectral groups* and to determine the parallaxes and projected linear separations of 153 visual double stars for which complete information concerning the spectral classes of their components was contained in the aforementioned paper but for which no acceptable parallaxes were known. As a check on the method, it has been extended to the cases of 85 systems discussed in the preceding paper for which reliable knowledge regarding the parallaxes as well as the spectral types was available. The hypothetical spectral parallaxes derived for these systems, in a large majority of cases, are found to be in good agreement with the previously known parallaxes.

Several other matters, chief among which are two possible orders of evolution pursued by double stars of different spectral characteristics, are also considered in the present paper.

ON THE PROPERTIES OF STARS IN SPACE.

By W. J. Luyten.

From the available trigonometric and hypothetical parallaxes a list of 104 stars has been compiled for which it is thought that the parallaxes exceed 0″.099. Besides parallaxes, the proper motions are known for all these stars, and spectral classes and radial velocities for many.

Knowledge of the masses and space velocities enables us to derive

the motion of the sun in space, under the assumption that the center of gravity of the stars considered is at rest in space. The result yields a velocity of 25 km/sec. directed toward R. A. 278° and Dec. +36°.

An analysis has been made of the physical properties of these stars, and it has been found that the frequency distribution of the logarithms of the tangential velocities, of the uncorrected and of the corrected space velocities follows a Gaussian error curve with remarkable precision. If we try to represent the distribution of the absolute magnitudes, of the logarithms of the masses, and of the logarithms of the kinetic energies by an error curve, the agreement is less close than in the case of the velocities, but may still be regarded satisfactory.

An analysis of the distribution in direction of the corrected space velocities reveals the existence of an axis of avoidance, and accordingly of a plane of preference, this plane being parallel to the plane of the Milky Way.

A plot of the quantities $H = m + 5 + 5 \log \mu$, and $M = m + 5 + 5 \log \pi$ shows a close correlation between H and M. Interpreted otherwise, this relation gives us the mean logarithm of the parallax expressed as a linear function of the apparent magnitude and proper motion, or, still otherwise, it gives a linear progression in the logarithm of the tangential velocity with the absolute magnitude. That the linearity of the relation between H and M is of a general character and not a local phenomenon may be inferred from a comparison of the present results with those derived previously for the B giants and the M dwarfs. These give the extension of the relation toward the two extreme ends, and in both cases the curves found previously agree very closely with the general straight line found here.

Assuming that the temperature of a star can be chosen as the one independent variable which determines the absolute magnitude and all other physical properties, the distributions of these properties may inversely be found from that in absolute magnitude. A functional relation has statistically been established between the absolute magnitude on one hand and on the other hand the color-index or reciprocal temperature, c_2/T, the linear diameter, D, and the density, ρ.

Under the assumption that Kapteyn's density law and luminosity law hold throughout the Universe, we can, from the data referred to above, compute the total mass of the Kapteyn system. This is found to be

1.4×10^9 times the sun's mass.

Assuming the velocities to be distributed in accordance with Maxwell's law we can also compute the number of collisions in the Universe by analogy with a perfect gas under low pressure. The result is

1.4×10^{-13} collisions per year.

SOME DOUBLY-ASYMPTOTIC ORBITS IN THE PROBLEM OF THREE BODIES.

By W. D. MacMillan.

This paper represents an effort to gain some insight into the transformation of a circular planetary orbit into an elliptical orbit by the passage of a star near the sun.

Since the general equations of motion for such a situation cannot be integrated, special cases and numerical processes have been resorted to. It is supposed that in its motion relative to the sun the orbit of the star is a parabola with a perihelion distance equal to unity. The radius of the circular planetary orbit is .36, or a little more than one third of the star's perihelion distance. For both the star and the planet the motion is forward.

Four orbits differing in phase by multiples of 90 degrees were computed. In orbit I the planet passed between the sun and the star at about the time the star was at its perihelion. Its orbit was violently perturbed, so that the eccentricity of the transformed orbit was .93, that is, it barely escaped collision with the sun. The other three orbits were transformed into more modestly eccentric ellipses. In all four cases the mean distance of the planet was reduced.

Diagrams of all four orbits were shown on the screen.

THE RADIAL VELOCITIES OF LONG-PERIOD VARIABLE STARS.

By Paul W. Merrill.

Radial velocity determinations of 133 long-period variables of classes Me and Se are now available for statistical study. Velocities were measured from both bright and dark lines for 47 stars. The relative displacements of the bright lines (toward shorter wave-lengths with respect to the dark lines) are found to increase, on the average, with advancing spectral type, increasing period range. The correlation with period is used for establishing an empirical correction to be applied to the bright-line velocities to reduce them to a dark-line basis, since the displacements of the dark lines rather than those of the bright lines appear to correspond to the true radial velocities. The absorption-line velocities are then made the basis for studies of the apparent solar motion. The speed of the sun is almost three times that usually found for K and M stars, but the position of the apex is nearly the same. The following values are representative: $A_0 = 281°$; $D_0 = +34°$; $V_0 = 53$ km; $K = +1$ km; arithmetic mean residual, 31 km. Sixty-eight stars with residual less than 25 km give $V_0 = 48$ km, and 65 with larger residuals, $V_0 = 65$ km. This increase in V_0 furnishes an excellent illustration of the well-known velocity asymmetry of high-speed stars. The average residual radial velocity is found to decrease with advancing spectral type and increasing period. Very high velocities are largely confined to stars of types M2e to M5e and to stars having periods in the neighborhood of 200 days.

HOW THE SUN'S ATMOSPHERE IS STUDIED AT ECLIPSES AND THE INTERPRETATION OF THE RESULTS THROUGH THE AID OF MODERN PHYSICS.

By S. A. Mitchell.

The sun exhibits spectra of three different types: (a) the ordinary or Fraunhofer spectrum; (b) the sun-spot spectrum; and (c) the chromospheric, which if observed at the time of an eclipse, is called the "flash spectrum". Compared with the Fraunhofer spectrum of type G0, the sun spots give a "later-type" spectrum, corresponding nearly to K0, while the flash spectrum represents the "earlier-type" of F0.

During the coming of the partial phase of an eclipse, the Fraunhofer spectrum of dark lines on a bright background persists unchanged until nearly the beginning of the total phase. The "high level" lines begin to appear gradually, jutting out beyond the dark-line spectrum. At the instant of totality all is changed. The spectrum now consists of bright lines on a black background, apparently every line of the solar spectrum being reversed. Before the eclipse of 1870, Young of Princeton predicted the sudden reversal, and his was the first eye to witness the phenomenon. The flash spectrum can also be observed without waiting for an eclipse, but up to the present the greatest success has been achieved at the time of a total eclipse.

If the flash spectrum were an *exact* reversal of the Fraunhofer lines, both as regards wave-lengths and intensities, the eclipse observations could add but little to our knowledge of solar physics. In fact, the flash spectrum is interesting and important only in so far as it differs from spectra taken under ordinary conditions. By photographing the eclipse spectrum without a slit and by measuring on the photographic plate the length of the arc subtended by each line of the spectrum it is readily possible to obtain the heights in kilometers that each vapor extends above the photosphere. The average depth of the reversing layer is about 600 km in thickness. A ray of light when coming to the observer from the bottom of a layer 500 km in thickness, at the time of an eclipse when tangential to the sun, would pass through 25,000 km of atoms before getting outside this relatively shallow layer. With a layer of this sort, the dark line would be caused by the absorbtive powers of 500 kms of atoms while the emission line, at the time of the eclipse, would depend on the radiation of atoms found in a length fifty times greater. Herein lies the cause of the remarkable differences in intensities found between the eclipse and ordinary spectra. The Fraunhofer spectrum is essentially an arc spectrum while the flash spectrum more closely resembles the spark spectrum. Especially prominent in the chromosphere are the "enhanced" lines, or those lines which are stronger in the spark than in the arc. Measures made on the eclipse spectra show conclusively that the enhanced lines ascend to much greater elevations above the photosphere than do the ordinary

lines. As a direct consequence of the increased elevations the pressures are greatly diminished. Modern theories of physics centered around the Bohr atom and Saha's valuable theory of ionization show that at the reduced pressures found at great elevations above the solar surface the atoms may be ionized, or in other words, they may lose one of their external electrons and thus have an excess charge of positive electricity. The ionized atom gives a different spectrum from that of the ordinary or neutral atom. The enhanced lines belong to the ionized atom, designated below by the + symbol. The following table will make these facts manifest. The intensities are there given for the *strongest* lines of the neutral and ionized atoms found in the sun and chromosphere, together with their intensities in the arc and spark and heights in kms above the photosphere.

Element	Wave-Length	Sun	Chromo-sphere	Arc	Spark	Height in km.
Ca	4227 (g)	20	25	1000	100	5,000
Ca +	3933 (K)	1000	100	500	1000	14,000
Ca +	3969 (H)	700	80	300	500	14,000
Sr	4607	1	2	1000	50	350
Sr +	4077	8	40	1000	1000	6,000
Sr +	4215	5	40	500	500	6,000
Ba	5535	2	1	100	30	400
Ba +	4554	8	20	1000	1000	1,200
Ba +	4934	7	12	100	300	750
Sc	4325	4	6	20	20	750
Sc +	4247	5	30	50	100	6,000

Heretofore it has always been difficult to understand why the H and K lines of calcium, of atomic weight 39, are much stronger in sun and chromosphere and extend to greater heights than the much lighter gas hydrogen. Saha's theory of ionization makes it plain that the hydogen lines in the solar spectrum belong to the *neutral* atom while H and K of calcium take their origin in the *ionized* atom, and that in consequence of the greatly reduced pressures found at great elevations the H and K lines are excessively strong.

The same theory applied to the stars has explained in a startling manner the causes of the changes of type and color as the stars progress in evolution (for the modern astronomer is a strong believer in evolution). The sun is the only one of the fixed stars near enough for us to study its atmosphere in detail, and for this reason, therefore, we should gather as much information as possible on the nearest of the fixed stars.

The theory of ionization also explains the causes of the differences between the spectrum of sun-spots and that of the sun, and an extension of this same theory gives a very plausible explanation of the corona, namely that it is a photo-electric effect.

STELLAR INTERFEROMETER WORK DURING 1922-1923.

By F. G. Pease.

The 20-foot stellar interferometer mounted on the 100-inch reflector has been used during this period: (*a*) to recheck the values of angular diameters obtained in previous years; (*b*) to continue measurements of visibilities of stars during all sorts of seeing in the endeavor to form a visibility-seeing scale so that all measures might be reduced to seeing 10, (*c*) to study atmospheric conditions.

(*a*) Practically all stars measured showed the same values as obtained previously. Betelgeuse alone showed an increased reading of the beam, indicating a smaller value for the angular diameter.

(*b*) Tentative curves have been obtained showing the relation between the visibility and the seeing for a number of the early-type stars and also curves showing the relation between visibility, seeing and stellar magnitude. Further data are essential before these curves can be completed.

(*c*) Interferometer work necessarily depends a great deal upon atmospheric conditions and much time has been spent studying the character of the image. Diffuse images always produce low visibilities. At times the zero or comparison images are not as good as the outer interferometer images, so for this reason too much reliance cannot as yet be placed upon the visibility-seeing curves.

With full aperture it has been found that astigmatic images are connected with upper air currents which show "schlieren" about 3 feet behind the focus, having the appearance of an extremely rapid flowing river, indicating a height of about a mile. Attention is called to papers by A. E. Douglass, and T. J. J. See in Vol. V, of Popular Astronomy and *A. N.* 3438 and 3449, in connection with atmospheric studies.

EXTENSION OF THE A. G. CATALOGS IN THE SOUTHERN SKY.

By C. D. Perrine.

In his address as retiring president of the Society, in September 1922, Dr. Schlesinger refers to the progress on the extension of the A. G. catalogs in the southern sky. As far as I know nothing has been published of the plans with respect to this work which were entered upon a number of years ago by the two Argentine observatories. It seems advisable in view of projects forming to publish a brief account of these and the present status of the work.

In 1909 when I assumed the direction of the Cordoba Observatory the reductions of the observations for the extension of the A. G. catalogs from —22° to —37° were nearing completion. The zones —22° to —27° (Vol. 22 of the *Resultados*) and —27° to —32° (Vol. 23) have been printed and distributed. The third zone, —32° to —37°,

was completed and the manuscript for the printer prepared about the beginning of the war, but owing to the dislocation caused by that upheaval it could not be printed. Various delays have occurred since but it is hoped to issue it next year.

In coöperation with the La Plata Observatory when Professor Hussey took charge of that institution in 1911 the Cordoba Observatory assumed responsibility for the next 15° or to —52° and the polar zone, —82° to —90°, where to simplify the DM zone it was planned to make one catalog answer for both DM and Zone catalogs. This left the region —52° to —82° which the La Plata Observatory undertook. Thus the two Argentine observatories planned the completion of this series of catalogs from —22° to the south pole.

It was my intention to do the —37° to —52° region by photography with a portrait lens of 45 inches focus, and the experimental photographs were taken and sufficient work done to show its accuracy and feasibility. This was before such a method was tested elsewhere so far as I know. Changing conditions have made it seem desirable to observe this zone with the meridian circle, thus making the entire work from pole to pole homogeneous in that respect. The commencement of the observing awaits the completion of the fundamental work under way, a matter of probably three years, when it will be taken up as part of another program.

The La Plata Observatory has already completed and published the zones —52° to —57° and —57° to —62°. I believe their third zone is under observation.

The polar zone, —82° to —90°, has been completely observed here, including photometric observations of the brightness of the stars, and the reductions are well along so that it is hoped to have the catalog ready for printing in 1924.

To recapitulate:

Published:
—22° to —32°
—52° to —62°

MS ready:
—32° to —37°

Observations completed and nearly ready:
—82° to —90°

Under Observation:
?—62° to —67°

This makes a total of 33° of the 68° from —22° to the south pole completely observed and for the most part published or nearly ready to publish. Approximately 30° remain to be observed, equivalent to but little more than 15° at the equator.

It is proper to add that the observations required to complete the Cordoba DM, —62° to —82°, have been begun and should be finished about the end of 1924. The observations for the DM maps, —42° to —62° and —82° to —90°, are ready and it is hoped to begin the preparation of the maps by the end of the present year.

Upon the return of the expedition from the northern hemisphere where it is expected to obtain the observations of the northern stars needed to supplement those for the fundamental catalog now nearing completion here, it is planned to begin the observations for the zone —37° to —52° and also a complete reobservation of the stars in the Cordoba General Catalog.

SPIRAL AND TEXTURELESS NEBULAE.

By C. D. Perrine.

In a study of diffuse galactic nebulae (*Astrophysical Journal* **56**, 162, 1922), E. B. Hubble objects to the classification of the "textureless" or structureless nebulae with spirals as generally practiced by astronomers and adduces as a reason that they show no traces of spiral structure, or indeed any structure at all.

For many years I have noticed this difference of structure and sometimes questioned the propriety of considering such structureless objects as spirals. The reasons for considering them separately did not seem as strong as those for continuing the old practice, at least for the present. It did and does seem, however, advisable to note the discordance in the appearance of these structureless objects and seek for further evidence of the cause.

Recently I have encountered two objects which appear to throw light on the relations of these structureless nebulae and the spirals and to justify their continued classification together, in different subdivisions perhaps, although even this much distinction may have to be modified or abandoned. The two nebulae in question are N. G. C. 1291 and 1097. Another, N. G. C. 1365, is also very suggestive in connection with the origin of spiral motion in this class of nebulae, and may have a relation to the structureless type.

N. G. C. 1291 appears to bear most directly upon any connection between the two classes. This object was described in a note to the Royal Astronomical Society published in *Monthly Notices* for June 1922.

The essential features of this nebula are a central, apparently structureless mass and an outer ring-like formation which when examined closely is seen to be composed of one and one half turns of a helix. It is possible that photographs with longer exposures and on a large scale may reveal other structural features. The spectrum is as yet unknown.

The known facts, however, point to a close relation between some form of spiral motion and these textureless masses in the case of 1291.

N. G. C. 1097 and 1365 may present even closer relations, depending upon the constitution of their central masses, for the spiral motion in these two cases is well marked. In 1097 the central mass is not large but otherwise has the appearance of a small structureless ball on our photograph. This is the most significant ϕ-type spiral known to me, as

the structural features in the central diametral arm are clearly marked.

N. G. C. 1365 is a fine rather large spiral 10′ long whose arms spring from a central portion which is clearly composed of two elongated masses. It is the only case I recall with what appears to be the very roots of the arms clearly marked.

The objects referred to have suggested the query whether the structureless objects may not be the gathering together of the primitive matter from which the spirals are formed, a stage of cosmical matter in the process of condensation, under its own gravitation alone perhaps, and before the operation of the forces which cause the condensations and the ejection of the arms.

A more complete description of these objects with illustrations is reserved for the volume on southern nebulae and clusters, in preparation at Cordoba.

RADIATION FROM THE PLANET MERCURY.

By Edison Pettit and Seth B. Nicholson.

Measurements of the radiation from the planet Mercury made with the vacuum thermocouple provided with a rock salt window, were compared with similar observations on the sun, moon, planets and stars. It was pointed out that the planetary radiation which enters the atmospheric transmission band in the region 8-14μ is wholly transmitted by the rock salt window, while it is only partially transmitted by fluorite. Some planetary radiation also enters through the region 1.3-5.5μ.

By use of a water cell and microscope cover glass as transmission screens, the energy in the regions 0.3-1.3μ, 1.3-5.5μ and 8-14μ was isolated. In the cases of the moon and planets the planetary heat entering the band 1.3-5.5μ can be distinguished from the reflected radiation in that region by a direct comparison with solar radiation. The following transmissions were observed:

Object		Transmissions			
				Planetary heat	
		.3μ-1.3μ	1.3μ-5.5μ	1.3μ-5.5μ	8μ-14μ
Mercury	crescent, west elongation	7.5	19.4	16.9	73.1
Mercury	gibbous, east elongation	8.2	27.6	24.6	64.2
Moon	6 da. old, mid. limb	12.3	23.9	19.3	63.8
Moon	limb one min. from horn	24.5	15.7	6.5	59.8
Jupiter	center of disk	78.3	15.5	....	6.2
Saturn	center of disk	77.6	14.5	....	7.9
Saturn's rings		75.2	23.3	....	1.5
Vega		79.9	19.4	....	0.7
δ Cephei	minimum	69.0	31.3	....	0.7
Sun	integrated light	72.8	26.7	....	0.5
Capella		66.9	30.8	....	2.3
Arcturus		53.3	44.7	....	2.0
β Pegasi		40.2	58.5	....	1.3
R Lyrae		31.9	65.8	....	2.3
X Ophiuchi	mag. 7.8	18.0	79.7	....	2.3
χ Cygni	mag. 10.5	18.3	76.8	....	4.9
o Ceti	mag. 8.4	18.6	74.8	....	6.6

From an inspection of the table the following conclusions may be drawn: (1) The planetary heat which we receive from Mercury and the moon is much the same and its distribution is very similar. This may indicate that, like the moon, Mercury has little or no atmosphere. (2) Some planetary heat is emitted by Jupiter and Saturn. (3) The radiation from Saturn's rings is probably all reflected sun-light. (4) A greater proportion of radiation is received from Jupiter and Saturn in the region 0.3μ-1.3μ than from the sun. This is difficult to understand. (5) Very little radiation of wave-length 8μ-14μ is sent us by the stars excepting those of the long-period variable class. The values for the stars found in this column need not be interpreted as meaning radiation from any dark bodies connected with these objects.

The first observation on Mercury and the first on the moon were made at the same phase angle. It will be noted that the spectral distributions of energy indicate a somewhat higher temperature for Mercury. This is confirmed by a comparison of the total amounts of planetary radiation emitted by these bodies. A measureable amount of radiation was detected on the dark side of Mercury at western elongation, which indicates a rather short rotation period.

JUPITER'S THIRD SATELLITE.

By W. H. Pickering.

A discussion of observations of the form of the disk of satellite III in 1923, which indicate a period of rotation of $3^h\ 11^m\ 20^s$. The period of satellite IV is believed to be identical with that of satellite III. From the irregularities in the form of the disk it is concluded that the satellite can not be a solid body, but must be composed of loose fragments like Saturn's rings. (Ed.)

A POSSIBLE ORIGIN OF THE NEBULAR LINES.

By H. H. Plaskett.

In a letter to *Nature* (September 15, 1923) it was suggested that the nebular lines might possibly have their origin in a molecule of small moment of enertia composed of atoms of those elements known to exist in nebulae. Such a molecule, it was shown, would give a spectrum free from band heads and indistinguishable from an ordinary line spectrum. The present paper summarized this hypothesis and presented some additional evidence favorable to certain band groupings suggested in the letter to *Nature*. The evidence resulted from the recent discovery here that the star Z Andromedae (Harvard type Oc) was actually a bright line A-type star with nebular lines due apparently to a surrounding envelope. These nebular lines are produced under the very highest excitation and furnish therefore an interesting test of the reality of the suggested band groupings. As far as the spectra of this star have been measured the suggested band groupings have been confirmed. The

paper concluded with a discussion as to the probable nature of the hypothetical molecule. It may be readily shown that its stability is quite different from the H_2 and He_2 molecules but that like them it is probably transparent when in an unexcited condition. Four elements are known to be present in nebulae, namely H, He, C, N. Confining attention to diatomic molecules there are five possible combinations the spectra of which are unknown (viz. H He, H N, He C, He N, C N), any one of which may be the originating molecule of the unknown lines in the nebular spectrum. A priori there is no reason to select one of these combinations as preferable to the others. All would have to be tried, as well as possible tri-atomic and tetra-atomic molecules, before a definite negative can be given to the hypothesis of a molecular origin. As a first guess, however, there is something to be said in favor of trying the H He molecule, in so far as the masses of the nuclei are small and their separation, to give a molecule of small moment of inertia, is of the order of the atomic radius. Aston has shown the existence of this molecule in his positive ray experiments but its spectrum has not yet been isolated.

THE WEDGE METHOD AND ITS APPLICATION TO ASTRONOMICAL SPECTROPHOTOMETRY.

By H. H. Plaskett.

This paper gives the result of work which has been in progress for some two or three years on the application of Merton and Nicholson's wedge method to astronomical spectrophotometry. The more important results of the investigation have been an accurate determination of the wedge constants, a verification of the validity of the method for laboratory standards, and the determination of the intensity distribution in the continuous spectrum of the sun and six typical stars. The most interesting result of the work has been to show that if the intensity be measured in regions comparatively free from absorption lines the sun radiates very much like a black body. The depression to the violet of 0.47μ shown in the energy curves of Abbot and of Wilsing is therefore probably to be ascribed to the effect of absorption lines. The paper is at present in press and will shortly appear as Vol. II, No. 12, of the Observatory publications.

TWO NEW CAMERA LENSES FOR SPECTROGRAPHS.

By J. S. Plaskett.

The Hastings-Brashear triplets so successful for one-prism work at an aperture ratio of f 10 give strongly concave fields when used with two and three prisms and cannot be used with larger ratio than about f 8. An adaptation of the Ross wide field astronomical camera lens has been made for the Victoria spectrograph and gives excellent definition and flat field with two and three prisms, while with one prism the field is strongly convex. This lens also can not be used with greater ratio

than f 8. However, Dr. G. W. Moffitt has designed a modified Petzvaal type of camera lens for spectrographs which can work at f 2. A lens of 3-inch aperture and 10-inch focus made for Victoria gives excellent definition and flat fields with two and three prisms but a convex field with one prism. This convexity of field with one-prism dispersion with both the Ross and Moffitt lenses is obviously due to the chromatic aberration of collimator and camera. This aberration is nearly compensated by the normal curvature of field of the camera lenses at the high dispersion of two and three prisms and results in a flat field, but at low dispersion the marginal foci are beyond the plane and we get convex fields. A short-focus lens of f 3 is being designed by Dr. Moffitt for use with one prism and will complete the equipment for linear dispersions varying between 10 and 90 A to the millimetre. It is evident that in designing camera lenses for spectrographs the color curve of the collimator must be taken into account and that it is hardly possible to obtain a camera objective which will perform equally well at all dispersions.

THE ABSORPTION LINE O-TYPE STARS.

By J. S. Plaskett.

This paper gives the results of an investigation by the writer of the radial velocities of all the known absorption line O-type stars within reach at Victoria, with a few additional examples discovered there, 45 in all. The lines normally are diffuse and the radial velocities correspondingly uncertain but about 30, two-thirds of them, appear to be variable in velocity, although the small ranges in some make the binary character uncertain. The average radial velocity, about 25 km per second, is considerably higher than for the B-type stars and a preliminary computation of the mean parallax of the group indicates a mean absolute magnitude about —3.5, also considerably brighter than the B's. This greater brightness is reasonably explained by greater mass as the two most massive systems known are of the O-type and probably most of these stars have large mass.

One of the most important and interesting results of the investigation is the curious behavior of the H and K lines of calcium. Although the other stellar lines are almost invariably diffuse, H and K are narrow and sharp and constant in velocity even when the other stellar lines vary. The H and K velocity is nearly always different from that given by the other lines, occasionally by as much as 50 km per second, and shows a tendency in some regions of the sky to agree quite closely with the component of the solar motion in that direction. The evidence seems to point to the sharp H and K as being due to the presence of interstellar clouds of calcium vapor not surrounding and moving with the stars and approximately at rest in some but not all regions, with respect to the systems of stars from which the solar motion has been determined. The Wolf-Rayet stars, O-type with emission bands, also show

sharp H and K absorption, with constant velocity agreeing closely with the solar component, but as these calcium lines are the only absorption lines appearing in their spectra, it cannot be determined how their velocity compares with the stellar velocities in these cases.

As it is probable from a preliminary survey of the Monoceros region that many stars classified among the early B's are in reality of O-type it is proposed to also observe all stars classified B0 to B5 north of —10° declination and brighter than visual magnitude 7.5 in order to complete the investigation for the high temperature stars.

RELATIVITY: AN APPROXIMATION.

By Charles Lane Poor.

An analysis of the methods and formulas of relativity, as given in the works of Professor A. S. Eddington, leads to the following conclusions:

1. The fundamental formulas of relativity dynamics contain an approximation: the r of these formulas is not the direct distance between the centres of two particles of matter; it is this distance increased by a minute quantity.

2. The relativity formulas can be obtained directly from the corresponding Newtonian formulas by the introduction of the relativity approximation.

3. The relativity motion of the perihelion of an orbit is a mathematical illusion, due entirely to the use of the relativity approximation. The elliptic orbit of a particle of matter is fixed in space when the interactions of the other planets are omitted.

4. The supposed confirmation of the Einstein theory by the motion of the perihelion of Mercury depends entirely upon the use of the approximation in the relativity formulas: when the approximation is removed from the formulas, all appearances of confirmation vanish.

5. Under the generalized theory of relativity, through the principle of equivalence, a ray of light, passing near the sun, will be bent by the same amount as under the corpuscular theory of light. The theoretical bending thus being the same for these two theories, a deflection, observed at an eclipse, cannot be used to prove the truth of the relativity theory as against that of the corpuscular theory of light.

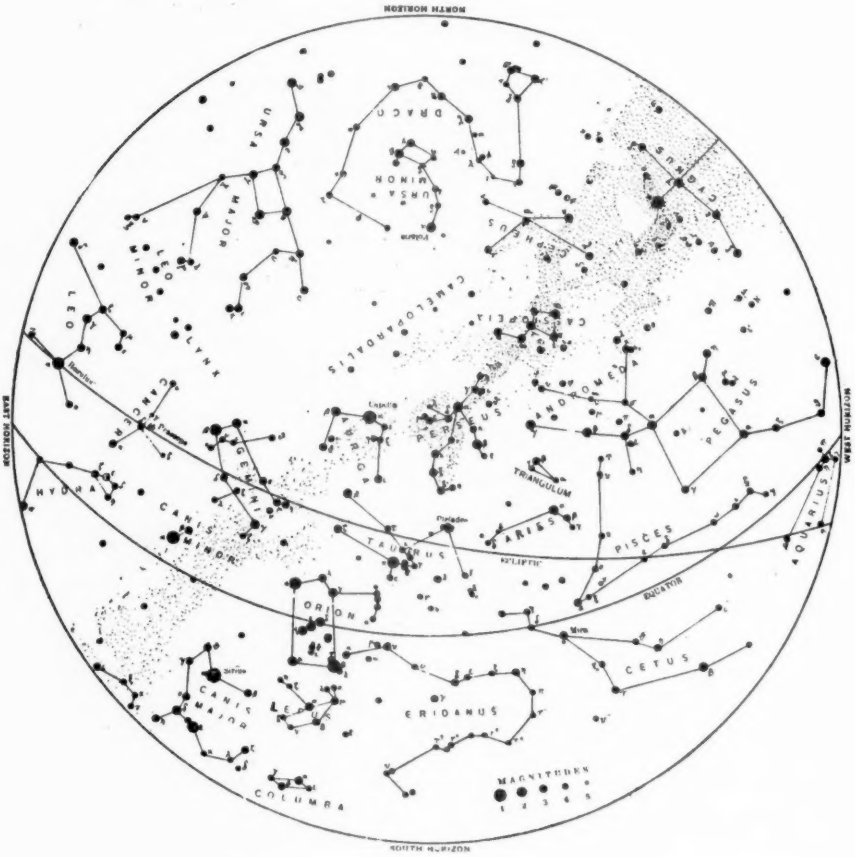
6. The figure, 1.75 seconds of arc, given by the relativitists for this deflection is obtained by an approximate and invalid calculation. The relativitists' own formulas give, as they should under the principle of equivalence, 0.87 seconds, and not 1.75.

7. The amount of deflection observed at the 1922 eclipse cannot be explained, either by the Einstein theory or by the corpuscular theory of light. Such deflection, if confirmed by later eclipses, will have to be explained on other grounds, by some purely physical cause, or by a combination of causes.

(To be continued.)

PLANET NOTES FOR JANUARY.

The *sun* will move eastward from $18^h\ 43^m$ to $20^h\ 55^m$, and northward from $-23°\ 5'$ to $-17°\ 22'$ during this month. It will pass from the constellation Sagittarius into the constellation Capricornus, through a region in which there are no bright stars.



THE CONSTELLATIONS AT 9:00 P. M. JANUARY 1.

The phases of the *moon* will occur as follows:

New Moon	January	6 at	7 A.M. C.S.T.
First Quarter		13 "	5 P.M. "
Full Moon		21 "	7 P.M. "
Last Quarter		28 "	12 P.M. "

The *moon* will be nearest the earth on January 4 and farthest from the earth on January 16, and will again be at its nearest point on January 31. When at its nearest point it is said to be in perigee and when at its farthest point, in apogee. These words correspond to the words perihelion and aphelion, which describe the position of the earth when nearest and farthest from the sun.

Mercury will move eastward until January 3, then westward until January 23. then eastward again for the rest of the month. It will pass the sun on the side towards the earth on January 13. At this time it will be said to be at inferior conjunction. It will be too near the sun to be visible during the month.

Venus will be conspicuous in the western sky during this month. It will be moving eastward faster than the sun, and hence will set later from night to night. At the end of the month it will set between two and a half and three hours after sunset. It will be a brilliant object although it will not attain its maximum brilliancy until later in the year.

Earth will be at the point nearest the sun on January 2. It will then be more than three million miles nearer the sun than on July 3 when it will be farthest from the sun. This difference in distance is due to the fact that the orbit of the earth is an ellipse and not an exact circle.

Mars will continue to move eastward more slowly than the sun. It will be visible in the morning. At the end of the month it will be a short distance east of the meridian at sunrise.

Jupiter also will be moving eastward slowly. It will be a short distance in the sky southeast of Mars during the month.

Saturn will be in quadrature, 90° west of the sun on January 23. It will be northwest from Mars and Jupiter.

Uranus at the beginning of the month will still be visible after sunset. At the end of the month it will be rather low in the west and not well situated for observation.

Neptune will be favorably situated for observation about midnight during the month. At the end of the month it will cross the meridian soon after midnight. It will be in the constellation Leo just west of Regulus.

Occultations Visible at Washington.

[*From the American Ephemeris.*]

Date 1924	Star's Name	Magnitude	IMMERSION. Washington M.T.	IMMERSION. Angle from N	EMERSION. Washington M.T.	EMERSION. Angle from N	Duration
			h m	°	h m	°	h m
Jan. 3	90 B. Ophiuchi	6.5	16 28	105	17 25	283	0 56
14	389 B. Ceti	6.3	12 12	62	13 12	271	1 0
16	179 B. Tauri	5.9	14 5	108	15 0	241	0 54
17	318 B. Tauri	5.7	14 14	84	15 16	273	1 2
19	74 B. Geminorum	6.2	17 37	109	18 28	264	0 51
20	*f* Geminorum	5.3	17 23	49	17 58	334	0 34
21	90 B. Cancri	6.3	19 8	153	19 42	234	0 34
29	190 B. Librae	6.5	17 53	83	19 5	317	1 12
30	24 Scorpii	5.0	17 27	111	18 43	282	1 15

VARIABLE STARS.

Minima of Variable Stars of Short Period.

[Calculated by members of the class in General Astronomy at Carleton College.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5^h; Central Standard time 6^h, etc.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1924 January							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8					15 17			
RT Sculptor.	31.5	—26 13	9.6—10 5	0 12.3	3 19	11 11	19 3	26 20				
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	2 11	9 23	17 10	24 22				
Z Persei	2 33 7	+41 46	9.4—12	3 01.4	6 9	12 11	18 14	24 17				
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	2 8	10 21	19 10	27 23				
RY Persei	39.0	+47 43	8.0—10.3	6 20 7	2 20	9 17	23 10	30 7				
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	5 16	12 20	20 1	27 4				
TX Cassiop.	44.4	+62 22	9.4—10 1	2 22.2	3 12	12 7	21 1	29 20				
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	2 1	9 23	17 21	25 20				
RX Cassiop.	2 58.8	+67 11	8.6— 9.1	32 07.6							27 15	
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	1 19	10 9	19 0	27 14				
RT Persei	16.7	+46 12	9 5—11.5	0 20.4	2 5	9 0	22 14	29 9				
λ Tauri	55.1	+12 12	3.3— 4.2	3 22 9	6 16	14 13	22 11	30 9				
RW Tauri	3 57.8	+27 51	7.1— 11	2 18 5	3 10	11 17	20 1	28 8				
RV Persei	4 04.2	+33 59	9.5—12.0	1 23.4	7 5	15 2	22 23	30 21				
RW Persei	13.3	+42 04	8.8—11 0	13 04.8	8 0		21 5					
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	4 21	11 5	23 19	30 2				
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10 1		12 20	25 5					
TT Aurigæ	5 02.8	+39 27	7.8— 8 7	0 16.0	1 10	8 1	21 9	28 1				
RY Aurigæ	11.5	+38 13	10.7—11.7	2 17 5	5 12	13 17	21 21	30 1				
RZ Aurigæ	42.9	+31 40	10.6—13.3	3 00.3	2 15	8 15	20 16	26 16				
SV Tauri	45.8	+28 05	9.4—11 0	2 04.0	3 13	12 5	20 21	29 13				
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9		11 2	21 12	31 22				
SV Gemin.	54.6	+24 28	9 8— 11	4 00.2	5 5	13 5	21 5	29 5				
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	2 6	7 23	19 10	25 4				
U Columbæ	6 11.2	—33 03	9.2—10 0	2 19.2	2 19	8 10	19 15	25 5				
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	8 15	16 20	25 1					
RW Monoc.	29 3	+ 8 54	9.0—10.8	1 21.7	2 19	10 10	18 1	25 16				
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0	8 13		20 18					
RU Monoc.	6 49.4	— 7 28	9.8—10.5	0 21.5	3 3	10 7	17 11	24 15				
R Can. Maj.	7 14.9	—16 12	5.8— 6.4	1 03.3	1 19	8 15	22 6	29 2				
RY Gemin.	21.7	+15 52	8 9— 10	9 07.2	5 23	15 6	24 13					
V Camelop.	27.6	+76 17	9.5—12	3 07.3	5 6	11 20	18 11	25 1				
TX Gemin.	30.3	+17 08	10.0—11 9	2 19.2	3 20	11 12	19 22	28 8				
RR Puppis	43.5	—41 08	9 4—10.7	6 10.3	7 4	13 14	20 0	26 11				
V Puppis	7 55.4	—48 58	4.1— 4.8	1 10.9	6 17	13 23	21 6	28 12				
X Carinæ	8 29 1	—58 53	7.9— 8.7	0 13.0	5 11	13 14	21 17	29 20				
S Cancri	8 38.2	+19 24	8.2—10	9 11.6	7 2	16 13	26 1					
RX Hydræ	9 00.8	— 7 52	9.1—10.5	2 06.8	4 16	11 12	18 8	25 5				
S Velorum	29.4	—44 46	7.8— 9.3	5 22.4	6 0	11 22	23 19	29 17				
V Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	2 4	8 22	22 9	29 3				
RR Velorum	10 17.8	—41 36	10.0—10 9	1 20.5	6 19	14 5	21 15	29 1				
SS Carinæ	10 54.2	—61 23	12.2—12.8	3 07.2	7 3	13 18	20 8	26 23				
ST Urs. Maj.	11 22.4	+45 44	6.7— 7.2	8 19.2	5 14	14 10	23 5					
RW Urs. Maj.	35.4	+52 34	10.3—11.4	7 07.9	2 12	9 20	24 12	31 20				
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	6 4	12 23	19 18	26 12				
RZ Centauri	12 55.6	—64 05	8.5— 8.9	1 21.0	3 4	10 16	18 4	25 16				
RS Can. Ven.	13 06.3	+36 28	7.5—12 5	4 19 1	5 11	15 0	24 16					
SS Centauri	07.2	—63 37	8.8—10.4	2 11.5	6 21	14 8	21 18	29 5				
SX Hydræ	13 90.0	—26 23	8.6—12.7	2 21.5	5 13	11 8	22 22	28 17				

Minima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1924 January							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
δ Libræ	14 55.6	— 8 07	4.8— 6.2	2 07.9	2 22	9 22	16 21	23 21				
U Coronæ	15 14.1	+32 01	7.6— 8.7	3 10.9	5 12	12 10	19 8	26 5				
TW Draconis	15 32.4	+64 14	7.3— 8.9	2 19.3	7 15	16 1	24 11					
SS Libræ	15 43.4	—15 14	9.3—11.5	0 18.4	3 18	10 23	18 3	25 8				
SW Ophiuchi	16 11.1	— 6 44	9.2—10.0	2 10.7	6 15	13 23	22 7	28 15				
SX Ophiuchi	12.6	— 6 25	10.5—11.2	2 01.5	7 19	16 1	24 7					
R Aræ	31.1	—56 48	6.8— 7.9	4 10.2	2 0	10 20	19 17	28 13				
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1		13 12						
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	2 9	9 4	22 19	29 14				
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	0 20.1	5 2	13 11	21 20	30 5				
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	5 20	12 0	24 7	30 11				
TX Herculis	15.4	+42 00	8.3— 9.0	1 06.7	6 10	12 15	24 23	31 3				
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	5 22	13 7	20 16	28 1				
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	4 8	12 12	20 17	28 21				
TX Scorpii	48.6	—34 13	7.5— 8.2	0 22.6	2 3	9 16	17 5	24 18				
UX Herculis	49.7	+16 57	8.8—10.5	1 15.2	8 12	16 6	24 0	31 18				
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	6 1	14 0	22 0	30 0				
WX Sagittarii	53.6	—17 24	9.2—10.8	2 03.1	3 8	11 21	20 9	28 22				
WY Sagittarii	17 54.9	—23 1	9.5—10.6	4 16.0	2 22	12 6	21 14	30 22				
SX Draconis	18 03.0	+58 23	9.3—10.5	5 04.1	5 16	10 20	21 5	26 9				
RS Sagittarii	11.0	—34 08	5.9— 6.3	2 10.0	4 16	11 22	19 4	26 10				
V Serpentis	11.1	—15 34	9.5—11.1	3 10.9	3 23	10 21	24 17	31 14				
RZ Scuti	21.1	— 9 15	7.4— 8.3	15 03.2		15 17		30 20				
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	7 10	14 14	21 18	28 22				
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	7 0	14 2	21 5	28 8				
SX Sagittarii	39.7	—30 36	8.7— 9.8	2 01.8	3 17	12 0	20 8	28 15				
RR Draconis	40.8	+62 34	9.3—13	2 19.9	2 8	10 20	19 8	27 20				
RS Scuti	43.7	—10 21	9.3—10.3	0 15.9	3 15	10 6	23 13	30 5				
β Lyræ	46.4	+33 15	3.4— 4.1	12 21.8	2 1	14 23	27 20					
U Scuti	18 48.9	—12 44	9.1— 9.6	0 22.9	4 23	12 14	20 5	27 20				
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	6 13	14 3	21 16	29 6				
RV Lyræ	12.5	+32 15	11. —12.8	3 14.4	7 11	14 6	21 11	28 15				
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	5 8	14 7	23 6					
U Sagittæ	14.4	+19 26	6.5— 9.0	3 09.1	1 20	8 14	22 3	28 21				
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	6 16	14 1	21 10	28 18				
TT Lyræ	24.3	+41 30	9.4—11.6	5 05.8	1 11	11 23	17 5	27 16				
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	2 21	9 10	22 11	28 23				
SY Cygni	19 42.7	+32 28	10. —12	6 00.2	6 3	12 3	24 3	30 3				
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	7 14	14 5	20 20	27 11				
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	1 9	10 13	19 16	28 20				
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	7 15	16 1	24 11					
RW Capric.	12.2	—17 59	8.8—10.6	3 09.4	3 17	10 12	24 2	30 21				
UW Cygni	19.6	+42 55	10.5—13	3 10.8	4 14	11 11	18 9	25 7				
V Vulpec.	32.3	+26 15	8.2— 9.8	37 19.0								
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	11 17	21 7	30 22					
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	5 6	14 11	23 15					
Y Cygni	48.1	+34 17	7.1— 7.9	1 12.0	5 19	14 19	23 19					
WZ Cygni	48.3	+38 27	9.9—10.8	0 14.0	6 18	14 9	21 23	29 13				
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	3 6	13 8	23 11					
RY Aquarii	21 14.8	—11.14	8.8—10.4	1 23.2	7 15	15 12	23 9	31 6				
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3	2 3							
RT Lacertæ	21 57.4	+43 24	9.1—10.5	5 01.7	1 22	12 1	22 5					
RW Lacertæ	22 40.6	+49 08	10.2—11.2	5 04.4	5 10	10 15	21 0	26 4				
VW Pegasi	51.7	+32 41	10.0—10.6	5 06.4	4 9	9 15	20 4	25 11				
Y Piscium	23 29.3	+ 7 22	9.0—12.0	3 18.3	4 12	12 1	19 14	27 3				
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	1 20	10 2	18 8	26 14				

Maxima of Variable Stars of Short Period.

[Calculated by members of the class in General Astronomy at Carleton College.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5^h; Central Standard time 6^h, etc.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1924 January							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SX Cassiop.	0 05.5	+54 20	8.6— 9.2	36 13.7			12 18					
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 1.7	5 3		13 6		21 10		29 13	
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	2 2		9 20		17 14		25 8	
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2			11 12		26 7			
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	6 6		14 5		22 3		30 2	
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	1 18		9 13		17 8		25 3	
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0	9 22		26 8					
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	6 12		15 2		23 16			
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1			10 17		21 20			
RX Aurigæ	4 54.5	+39 49	7.2— 8.1	11 15.0	6 13		18 4		29 19			
SX Aurigæ	5 04.6	+42 02	8.0— 8.7	1 12.8	4 9		12 1		19 17		27 9	
SY Aurigæ	05.5	+42 41	8.4— 9.5	10 03.3	9 1		19 5		29 8			
Y Aurigæ	21.5	+42 21	8.6— 9.6	3 20.6	2 20		10 13		18 6		26 0	
RZ Gemin.	5 56.6	+22 15	9.1—10.0	5 12.7	2 11		9 23		19 1		24 14	
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	5 15		13 5		20 18		28 8	
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3	2 10				29 10			
RT Aurigæ	23.0	+30 33	5.1— 6.0	3 17.5	9 12		16 23		24 10		31 21	
W Gemin.	29.2	+15 24	6.7— 7.5	7 22.0	1 18		9 16		17 14		25 12	
ζ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	2 12		12 16		22 20			
RU Camelop.	7 10.9	+69 51	8.5— 9.8	22 06.5	3 19				26 1			
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	6 17		14 16		22 15		30 13	
V Carinæ	8 26.7	—59 47	7.4— 8.1	6 16.7	5 16		12 9		19 1		25 18	
T Velorum	8 34.4	—47 01	7.6— 8.5	4 15.3	5 21		15 3		24 10			
V Velorum	9 19.2	—55 32	7.5— 8.2	4 08.9	4 16		13 10		22 3		30 21	
Z Leonis	9 46.4	+27 22	7.9— 9.6	59 00.0								
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	3 12		10 17		23 21		30 16	
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	4 18		11 5		22 10		31 1	
S Muscae	12 07.4	—69 36	6.4— 7.3	9 15 8	3 2		12 18		22 9			
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	3 21		11 20		19 20		27 19	
T Crucis	15.9	—61 44	6.8— 7.6	6 17.6	8 16		15 9		22 3		28 20	
R Crucis	18.1	—61 04	6 8— 7.9	5 19.8	2 23		8 19		20 11		26 6	
S Crucis	12 48.4	—57 53	6.5— 7.6	4 16.6	2 15		12 0		21 9		30 18	
W Virginis	13 20 9	— 2 52	8.7—10.4	17 06.5			11 7		28 13			
SS Hydræ	25.0	—23 08	7.4— 8.1	8 04.8	6 5		14 10		22 14		30 19	
RV Urs. Maj.	13 29.4	+54 31	9.2— 9 9	0 11.2	2 1		9 2		23 3		30 3	
ST Virginis	14 22.5	— 0 27	10.3—11.4	0 09.9	5 9		13 14		21 20		30 1	
V Centauri	25.4	—56 27	6.4— 7.8	5 11.9	3 9		8 20		19 20		25 8	
RS Bootis	29.3	+32 11	8.9—10.0	0 09.1	5 17		13 6		20 19		28 9	
R Triang.Austr.	15 10.8	—66 08	6.7— 7.4	3 09.3	1 9		8 3		21 17		28 11	
S Triang.Austr.	15 52.2	—63 29	6.4— 7.4	6 07.8	2 5		8 13		21 5		27 12	
S Normæ	16 10.6	—57 39	6.6— 7.6	9 18.1	2 5		11 23		19 17		29 11	
RW Draconis	33.7	+58 03	9.6—10 8	0 10.6	9 11		18 7		27 4			
RV Scorpii	16 51.8	—33 27	6.7— 7.4	6 01.5	1 22		6 23		19 3		25 4	
X Sagittarii	17 41.3	—27 48	4.4— 5.0	7 00.3	6 8		13 18		20 18		27 19	
Y Ophiuchi	47.3	— 6 07	6.1— 6.5	17 02.9	9 17				26 20			
W Sagittarii	17 58.6	—29 35	4.3— 5.1	7 14.3	2 18		10 9		17 23		25 13	
Y Sagittarii	18 15.5	—18 54	5.4— 6.2	5 18.6	3 19		9 13		21 2		26 21	
U Sagittarii	26.0	—19 12	6.5— 7.3	6 17.9	6 1		12 19		19 13		26 7	
Y Scuti	32.6	— 8 27	8.7— 9.2	10 08.3	2 20		13 4		23 12			
RZ Lyræ	18 39.9	+32 42	9.9—11.2	0 12.3	9 2		15 5		21 8		27 12	
RT Scuti	18 44.1	—10 30	9.1— 9.7	0 11.9	4 18		10 17		22 15		28 13	
κ Pavonis	18 46.6	—67 22	3.8— 5.2	9 02.2	8 19		17 21		26 23			
U Aquilæ	19 24.0	— 7 15	6.2— 6.9	7 00.6	4 15		11 15		18 16		25 16	

Maxima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1924 January					
	h m	° ′		d h	d h	d h	d h	d h	d h	d h
XZ Cygni	19 30.4	+56 10	8.6— 9.3	0 11.2	6 20	13 20	20 20	27 20		
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	7 6	15 5	23 5	31 4		
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	1 1	8 18	24 3	31 20		
η Aquilæ	47.4	+ 0 45	3.7— 4.5	7 04.2	5 14	12 18	19 23	27 3		
S Sagittæ	51.5	+16 22	5.6— 6.4	8 09.2	8 13	16 22	25 7			
X Vulpec.	19 53.3	+26 17	9.5—10.5	6 07.7	4 9	10 17	23 8	29 16		
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3	5 14		21 23			
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	4 22	13 19	18 5	27 2		
WY Cygni	52.3	+30 03	9.6—10.4	0 13.5	1 5	7 22	21 9	28 3		
RV Capric.	55.9	—15 37	9.2—10.1	0 10.7	1 2	7 19	21 5	27 22		
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4	6 19		21 12			
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	5 2	12 23	20 19	28 16		
SW Aquarii	10.2	— 0 20	9.9—10.8	0 11.0	2 21	9 18	23 13	30 10		
VZ Cygni	21 47.7	+42 40	8 2— 9.2	4 20.7	3 16	8 13	18 6	23 3		
Y Lacertæ	22 05.2	+50 33	9.1— 9.6	4 07.8	7 10	16 2	24 18			
δ Cephei	25.5	+57 54	3.7— 4 6	5 08.8	1 18	12 12	17 20	28 14		
Z Lacertæ	36.9	+56 18	8.2— 9.0	10 21.1	5 1	16 6	27 3			
RR Lacertæ	37.5	+55 55	8.5— 9.2	6 10.1	3 1	9 11	22 7	28 17		
V Lacertæ	44.5	+55 48	8.5— 9.5	4 23.6	2 23	7 23	17 22	27 21		
X Lacertæ	22 45.0	+55 54	8.2— 8.6	5 10.7	5 8	10 18	21 16	27 2		
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	2 18	13 15	19 2	29 23		
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	1 21	8 5	20 19	27 2		
RY Cassiop.	47.2	+58 11	9.3—11 8	12 03.4	1 10	13 14	25 17			
V Cephei	23 51.7	+82 38	6.0— 7.0	0 23.9	1 11	8 11	22 10	29 10		

Monthly Report of the American Association of Variable Star Observers, Sept. 20—Oct. 20, 1923.

Our unusually large report has many features of interest, and represents not only the splendid work of older observers, but the first contributions of six new observers, Messrs. Barringer, Chisolm, Gaebler, Iedema, Keay, and Miss Lacchina, of Faenza, Italy, whose father has earned an enviable record as an indefatigable observer of variables. The Association has several small telescopes for loan to members who will agree to use them for variable star observation. The Slide Committee is revising the Slide Catalogue, preparing a description of each slide as an aid to the lecturer, and will welcome further accessions to the set at an early date, in order that the Third Catalogue may be made as complete as possible.

Dr. and Mrs. Paraskevopoulos have gone to Arequipa, Peru, to relieve Professor Bailey as officer in charge of the Harvard College Observatory station there. Professor Bailey is due to return to Cambridge before January 1, 1924.

Honorable mention should be made of our Japanese members for their almost unbroken observing records in spite of the earthquake calamity.

The following observers contributed to this report: Messrs. Ancarani "An", Baldwin "Bl", Barringer "Bi", Bouton "B", Brocchi "Br", Carr "Ca", Chandler "Cd", Chandra "Ch", Chisolm "Cm", Christie "Ct", Cilly "Cy", Fant "Ft", Ferry "Fe", Godfrey "Gd", Gaebler "Gb", Hunter "Hu", Iedema "Ie", Kanda "Kd", Keay "Ke", Kleis "Kl", Lacchini "L", Miss Lacchini "Lh", Leavenworth "Lv", Mrs. Lytle "Ly", McAteer "M", Nakamura "Nk", Olcott "O", Peltier "Pt", de Perrot "Pe", Pickering "Pi", Rhorer "Ro", Skaggs "Sg", Waterfield "Wf" and Yalden "Ya".

VARIABLE STAR OBSERVATIONS, September 20 to October 20, 1923

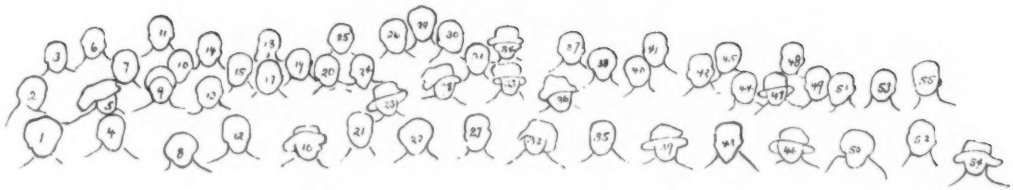
September 0 = J. D. 2423663 — October 0 = J. D. 2423693

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
001032 S SCULPTORIS—						
	3638.1	10.5	Bl.	3657.0	9.4	Bl.
	3650.1	9.1	Bl.			
001046 X ANDROMEDAE—						
	3677.7	9.9	Wf.	3670.6	10.0	O.
	3680.7	10.1	Br.	3701.6	9.1	M.
	3692.6	9.7	Wf.	3702.8	10.1	Wf.
	3694.6	10.1	O.	3706.6	9.4	Pi.
	3695.6	9.5	Pt.	3706.8	9.5	Lv.
	3696.8	9.8	Lv.	3709.6	9.3	Hu.
001620 T CETI—						
	3664.1	6.2	Kd.	3682.5	6.1	An.
	3668.2	6.3	Kd.	3693.3	6.2	L.
	3670.6	6.4	L.	3698.3	5.7	An.
	3670.6	6.1	An.			
001726 T ANDROMEDAE—						
	3678.8	12.8	Br.	3700.7	13.5	Lv.
	3695.6	13.6	Pt.			
001755 T CASSIOPEIAE—						
	3670.3	8.1	Pe.	3695.6	7.8	Pt.
	3672.4	7.7	L.	3698.6	8.2	Pi.
	3674.4	8.0	An.	3700.5	7.7	Ca.
	3687.6	7.6	Ca.	3701.6	8.0	M.
	3688.6	8.1	O.	3708.6	8.6	Pi.
	3691.6	7.7	B.	3709.5	7.9	Gd.
	3693.3	7.9	Pe.	3709.6	8.0	O.
	3693.8	8.5	Br.	3710.5	7.6	Ca.
	3694.3	7.7	L.			
001838 R ANDROMEDAE—						
	3674.0	14.0	Nk.	3693.7	14.5	Wf.
	3675.7	14.3	Wf.	3695.6	13.4	Pt.
001862 S TUCANAE—						
	3638.1	9.6	Bl.	3657.0	9.5	Bl.
	3650.1	9.2	Bl.			
001909 S CETI—						
	3670.6	12.5	L.	3695.6	11.7	Pt.
	3694.3	11.9	L.	3700.6	11.1	Ca.
	3694.6	12.1	Pi.	3701.6	10.6	M.
	3695.6	11.8	O.	3702.8	10.0	Sg.
002546 T PHOENICIS—						
	3638.1	10.2	Bl.	3657.0	11.0	Bl.
002833 W SCULPTORIS—						
	3638.1	12.5	Bl.			
004047 U CASSIOPEIAE—						
	3677.7	14.3	Wf.	3695.6	14.2	Pt.
004132a RW ANDROMEDAE—						
	3673.2	10.2	Ch.	3695.6	8.4	Pt.
	3677.7	10.0	Wf.	3701.6	8.2	Pi.
	3689.7	8.6	Br.	3702.8	8.3	Wf.
	3692.6	8.6	Wf.			
004435 V ANDROMEDAE—						
	3689.8	9.8	Br.	3699.6	9.8	O.
	3692.6	9.8	O.	3706.8	10.0	Lv.
	3696.8	9.8	Lv.	3709.6	10.6	O.
	3698.6	9.8	Pi.	3709.6	11.0	Hu.
004435 X SCULPTORIS—						
	3639.2	10.3	Bl.	3657.0	10.3	Bl.
	3650.1	10.1	Bl.			
004533 RR ANDROMEDAE—						
	3677.7	11.5	Wf.	3701.6	10.7	Pi.
	3690.7	11.1	Br.	3702.8	10.9	Wf.
	3692.6	11.0	O.	3709.5	10.8	O.
	3692.6	10.9	Wf.	3709.6	10.5	Hu.
	3699.6	10.8	O.			
004746a RV CASSIOPEIAE—						
	3671.4	14.2	L.	3695.6	13.1	B.
	3677.7	14.6	Wf.	3695.6	13.0	Pt.
	3693.7	13.8	Wf.	3702.7	12.3	Br.
	3694.3	13.3	L.	3702.8	12.0	Wf.
004958 W CASSIOPEIAE—						
	3685.7	11.1	Br.	3698.6	11.9	Pi.
	3691.6	11.6	B.	3702.7	11.6	Br.
	3694.6	11.8	O.	3709.5	11.5	Gd.
	3695.6	11.2	Pt.			
005475 U TUCANAE—						
	3639.2	12.7	Bl.			
010102 Z CETI—						
	3694.6	9.2	Pi.	3695.6	9.3	Pt.
010940 U ANDROMEDAE—						
	3677.7	13.5	Wf.	3702.8	13.8	Wf.
	3693.7	13.6	Wf.			
011041 UZ ANDROMEDAE—						
	3677.7	14.8	Wf.	3693.7	14.6	Wf.
011208 S PISCIUM—						
	3678.9	9.3	Br.	3694.6	9.8	O.
011272 S CASSIOPEIAE—						
	3677.7	8.7	Wf.	3701.5	9.3	Pi.
	3679.6	8.5	Ie.	3701.6	8.5	M.
	3692.6	9.0	Wf.	3702.8	9.1	Wf.
	3695.6	8.5	Pt.	3709.5	9.5	Gd.
011712 U PISCIUM—						
	3678.9	11.5	Br.	3695.6	11.7	Pt.
	3693.8	12.0	Br.	3699.8	12.0	M.
	3694.6	11.7	O.	3701.7	12.1	Pi.
012350 RZ PERSEI—						
	3684.8	13.2	Br.	3702.7	13.0	Br.
012502 R PISCIUM—						
	3678.9	12.6	Br.	3700.8	11.4	Lv.
013238 RU ANDROMEDAE—						
	3677.7	13.3	Wf.	3702.8	13.4	Wf.
	3692.6	13.3	Wf.			
013338 Y ANDROMEDAE—						
	3670.1	9.8	Ch.	3695.6	11.1	Pt.
	3677.7	9.5	Wf.	3698.6	11.0	Pi.
	3690.8	10.7	Br.	3702.8	11.5	Wf.
	3692.6	10.3	Wf.	3704.7	11.4	Br.
014958 X CASSIOPEIAE—						
	3691.6	10.0	B.	3701.6	11.3	M.
	3695.6	10.3	Pt.			
015354 U PERSEI—						
	3688.7	8.5	Sg.	3701.6	8.7	M.
	3693.6	8.5	O.	3701.6	8.5	O.
	3695.6	8.5	Pt.	3703.7	8.5	Sg.
	3698.6	8.4	Pi.	3710.5	8.5	Gd.
015912 S ARIETIS—						
	3695.6	13.9	Pt.			

PLATE XL.

MEETING OF THE AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS AT HARVARD COLLEGE OBSERVATORY, OCTOBER 13, 1923.

KEY TO PLATE XL.



1. Miss Cushman
2. Miss Hodgdon
3. R. N. Mayall
4. M. F. Jordan
5. Mrs. C. W. Elmer
6. W. W. Bickell
7. M. J. Jordan
8. Miss Gushee
9. Mrs. M. F. Jordan
10. W. D. MacPherson
11. Mr. Burley
12. R. O. Suter
13. Miss Farnsworth
14. G. C. Waldo
15. Leon Campbell
16. Miss Woods
17. E. B. Jones
18. J. E. G. Yalden
19. D. B. Pickering
20. Luis Rodés
21. H. W. Culp
22. Miss Clough
23. Miss Gill
24. E. F. Sawyer
25. C. T. Whitehorn
26. C. W. Elmer
27. D. B. Prentice
28. Mrs. D. B. Pickering
29. W. J. Luyten
30. M. Cilley
31. W. T. Olcott
32. Miss Young
33. Mrs. W. T. Olcott
34. Mrs. L. I. Boss
35. Harlow Shapley
36. Mrs. E. F. Sawyer
37. C. Y. McAteer
38. Miss Ames
39. Miss Cannon
40. Miss Payne
41. L. J. Boss
42. W. J. Reardon
43. C. C. Godfrey
44. Miss Walker
45. William Henry
46. Mrs. G. C. Waldo
47. Miss Murdock
48. J. P. Fox
49. S. B. Cummings
50. Miss Howarth
51. W. J. Fisher
52. P. R. Allen
53. W. H. Cudworth
54. Mrs. Holmes
55. J. H. Metcalf

VARIABLE STAR OBSERVATIONS, September 20 to October 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
021024 R ARIETIS—						
	3670.4	10.4	Pe,	3700.6	9.6	Kl,
	3670.6	12.3	L.,	3701.6	9.5	Kl,
	3675.6	12.3	Kl,	3702.6	9.4	Kl,
	3675.7	12.4	Wf,	3702.8	9.8	Wf,
	3684.7	11.4	Kl.	3704.6	9.3	Kl,
	3684.9	11.4	Br.	3704.7	10.0	Br,
	3685.7	11.1	Wf,	3706.8	9.5	Lv,
	3693.7	9.9	Wf,	3707.7	9.3	Kl,
	3694.3	9.7	L,	3708.6	9.3	Ca,
	3694.6	10.0	O,	3709.6	9.2	O,
	3695.6	10.5	Pt,	3712.7	9.1	Kl,
	3695.6	9.9	Kl,	3714.7	9.0	Kl,
	3695.6	9.9	Ca,	3716.6	8.6	Kl,
	3697.6	9.8	Kl,	3724.6	8.5	Kl.
	3699.5	10.0	Pi,			
021143a W ANDROMEDAE—						
	3674 0	11.4	Nk,	3693.6	9.7	O,
	3677.7	11.1	Wf,	3695.6	9.5	Pt,
	3685.0	10.7	Nk,	3698.6	9.4	Pi,
	3690.8	10.0	Br,	3702.8	8.8	Wf.
	3693.7	9.6	Wf,			
021258 T PERSEI—						
	3699.6	8.3	Pt.			
021281 Z CEPHEI—						
	3695.6	13.3	Pt.			
021403 o CETI—						
	3626.7	9.1	Cy,	3695.6	9.0	O,
	3670.6	8.9	An,	3699.7	9.1	Pt.
	3670.6	8.6	L,	3700.8	9.3	Kl,
	3673.2	9.0	Ch,	3701.7	9.2	Gb,
	3674.6	8.9	An,	3702.7	9.0	Kl,
	3680.7	9.0	Cy,	3702.8	9.0	Sg,
	3680.8	9.0	Sg,	3707.7	8.8	Kl,
	3682.5	9.0	An,	3712.7	9.2	Kl,
	3694.6	9.0	L,	3714.7	9.4	Kl,
	3694.6	9.2	Pi,	3723.7	9.0	Kl.
021558 S PERSEI—						
	3668.2	9.7	Ch,	3699.6	8.8	Pt,
	3672.8	9.0	Pt,	3710.5	9.0	Gd.
	3699.5	9.4	Pi,			
022000 R CETI—						
	3673.2	10.3	Ch,	3695.6	8.6	O,
	3692.7	8.3	Ca,	3709.6	8.4	Ca.
022150 RR PERSEI—						
	3693.7	14.2	Wf,	3702.8	14.2	Wf.
	3699.7	13.4	Wf,			
022426 R FORNACIS—						
	3639.2	8.0	Bl,	3657.0	7.5	Bl.
	3650.1	8.1	Bl,			
022813 U CETI—						
	3699.7	11.7	Pt.			
022980 RR CEPHEI—						
	3669.3	11.3	L,	3693.8	12.5	Br,
	3677.7	11.8	Br,	3695.6	12.3	Pt,
	3693.3	12.3	L,	3701.6	12.2	Pi,
	3693.7	12.3	Wf,	3702.8	12.6	Wf.
023133 R TRIANGULI—						
	3673.7	9.4	Ie,	3699.7	9.7	Pt,
	3684.8	9.0	Br,	3704.7	9.8	Br,
	3693.6	9.7	O,	3709.6	10.7	O.
024356 W PERSEI—						
	3655.0	9.1	Nk,	3699.5	9.7	Pi,
	3676.6	9.5	Cm,	3699.6	9.8	O.
	3677.6	9.3	Cm,	3699.7	9.7	Pt,
	3688.6	9.2	O,	3708.5	9.1	Ca.
	3692.6	9.8	Cm,	3710.5	9.4	Gd.
	3693.5	9.1	Ca,			
025050 R HOROLOGII—						
	3639.6	6.7	Bl.	3657.0	6.6	Bl.
	3650.1	6.7	Bl,			
025751 T HOROLOGII—						
	3639.2	12.4	Bl.	3657.0	10.8	Bl.
	3650.1	11.5	Bl,			
030514 U ARIETIS—						
	3684.9	13.3	Br.			
031401 X CETI—						
	3670.6	9.7	L,	3695.6	11.3	O,
	3675.7	9.7	Wf,	3699.7	11.7	Pt.
	3694.6	11.8	Wf,	3702.8	12.0	Wf.
	3694.7	11.7	Wf,			
032043 Y PERSEI—						
	3674.2	9.3	Nk,	3699.7	8.4	Pt,
	3694.6	9.4	O,	3709.6	8.2	Hu.
032335 R PERSEI—						
	3676.7	12.3	Wf,	3699.7	11.8	Pt,
	3678.9	12.3	Br,	3700.6	11.0	Ca,
	3692.8	12.1	Br,	3701.6	11.0	M,
	3693.7	12.0	Wf,	3702.8	11.7	Wf.
042209 R TAURI—						
	3699.7	13.2	Pt.			
042215 W TAURI—						
	3678.9	12.4	Br.	3702.8	11.7	Sg.
	3698.6	11.8	O.	3707.7	11.6	Kl.
	3699.7	11.5	Pt.	3712.7	11.6	Kl,
	3699.8	12.0	M,	3714.7	11.6	Kl,
	3701.7	11.6	Pi.	3723.7	11.1	Kl.
	3702.7	11.9	Kl,			
042309 S TAURI—						
	3699.7	14.1	Pt.			
043065 S CAMELOPARDALIS—						
	3672.4	9.5	L,	3699.7	10.0	Pt,
	3678.9	9.7	Br,	3700.6	10.6	O,
	3693.6	10.8	O,	3701.6	11.2	Pi.
043208 RX TAURI—						
	3699.7	14.4	Pt.			
043262 R RETICULI—						
	3639.2	10.2	Bl,	3657.0	10.8	Bl.
	3650.1	10.7	Bl,			
043274 X CAMELOPARDALIS—						
	3676.7	8.4	Wf,	3700.6	10.6	O.
	3679.7	8.5	Br,	3701.6	10.6	Pi,
	3693.6	10.3	O,	3701.7	10.8	Br.
	3693.7	9.7	Wf,	3710.6	12.0	O.
	3699.7	10.8	Pt,			
043562 R DORADUS—						
	3639.3	5.0	Bl,	3650.1	5.2	Bl.
043738 R CAELI—						
	3639.3	11.8	Bl,	3655.2	12.1	Bl.
044349 R PICTORIS—						
	3639.3	7.8	Bl,	3650.1	8.2	Bl.

VARIABLE STAR OBSERVATIONS, September 20 to October 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
044617 V TAURI—						
	3675.7	11.9	Wf,	3699.7	9.7	Pt,
	3679.0	12.0	Br,	3701.7	10.0	Pi,
	3694.7	10.7	Wf,	3702.8	9.9	Wf.
045307 R, ORIONIS—						
	3679.0	9.5	Br.			
045514 R LEPORIS—						
	3670.7	7.6	L,	3699.7	7.0	Pt,
	3674.7	7.7	L,	3700.7	7.3	Ca,
	3694.7	7.3	L,	3709.8	7.3	Ca.
050003 V ORIONIS—						
	3679.0	12.3	Br,	3699.7	13.2	Pt.
050022 T LEPORIS—						
	3639.3	12.6	Bl,	3699.7	11.1	Pt,
	3655.2	12.0	Bl,	3710.9	10.5	M.
050953 R AURIGAE—						
	3676.7	13.0	Wf,	3699.7	12.6	Pt.
	3684.8	12.7	Br,	3702.8	11.7	Wf.
	3693.7	12.5	Wf,			
051247 T PICTORIS—						
	3639.3	8.0	Bl,	3650.1	8.1	Bl.
051533 T COLUMBAE—						
	3639.3	8.2	Bl,	3655.2	9.5	Bl.
052034 S AURIGAE—						
	3673.6	9.4	L.	3701.7	10.5	Pi,
	3699.7	9.0	Pt,	3703.8	9.0	Sg.
052036 W AURIGAE—						
	3664.6	11.0	L,	3699.7	8.7	Pt,
	3675.5	9.5	L,	3709.6	8.6	O.
	3684.9	9.3	Br,			
052404 S ORIONIS—						
	3693.0	9.9	Br,	3700.7	9.3	Ca,
	3699.7	9.4	Pt,	3709.7	8.3	Ca.
	3699.8	9.5	M.			
053005a T ORIONIS—						
	3673.6	9.7	L,	3697.8	10.0	Pt,
	3674.6	9.9	L,	3699.7	10.5	Pt,
	3674.6	9.9	An,	3699.8	10.6	M,
	3676.6	10.0	L,	3700.8	10.5	Pt,
	3688.7	11.1	L,	3702.8	10.5	Pt,
	3694.6	10.3	L,	3703.8	10.0	Sg.
053068 S CAMELOPARDALIS—						
	3693.6	8.3	O,	3701.6	8.6	Pi.
	3699.7	8.2	Pt,			
053531 U AURIGAE—						
	3684.9	11.1	Br,	3699.7	11.6	Pt.
	3696.6	11.3	O,			
054319 SU TAURI—						
	3670.6	9.6	L,	3697.8	9.6	Pt,
	3674.6	9.4	L,	3699.7	9.6	Pt,
	3674.6	9.3	An,	3699.8	9.5	M,
	3678.9	9.4	Wf,	3700.8	9.6	Pt,
	3678.9	9.4	Br.	3702.8	9.6	Pt,
	3679.9	9.4	Wf,	3702.8	9.4	Wf,
	3690.9	9.8	Br,	3703.7	9.6	Pt,
	3692.8	9.7	Br.	3711.7	9.5	Pt.
	3696.8	9.5	Wf,			
054331 S COLUMBAE—						
	3639.3	10.5	Bl.	3655.2	11.4	Bl.
054615a Z TAURI—						
	3678.9	12.5	Wf,	3692.8	13.0	Br.
054615c RU TAURI—						
	3678.9	12.7	Wf,	3692.8	13.0	Br.
054639 R COLUMBAE—						
	3639.3	10.1	Bl,	3655.3	10.0	Bl.
054920a U ORIONIS—						
	3679.0	7.0	Br,	3699.7	7.0	Pt,
	3680.8	7.5	Cy,	3699.8	7.3	M,
	3692.7	6.9	Ca,	3707.7	7.6	Gb,
	3696.7	8.1	Cy,	3709.7	7.4	Ca.
054974 V CAMELOPARDALIS—						
	3676.7	14.1	Wf.			
055353 Z AURIGAE—						
	3676.7	10.6	Wf,	3699.8	9.4	M,
	3693.7	10.2	Wf,	3702.8	10.0	Wf.
	3699.7	9.9	Pt,			
055686 R OCTANTIS—						
	3635.9	11.2	Bl,	3656.9	11.0	Bl.
	3649.9	11.0	Bl,			
060450 X AURIGAE—						
	3684.9	12.7	Br,	3699.7	11.6	Pt.
060547 SS AURIGAE—						
	3664.6	[13.3	L,	3692.8	[13.0	Br,
	3670.5	[13.0	L,	3693.7	[13.5	Wf,
	3670.8	[11.6	Kl,	3694.6	[11.6	Pi,
	3671.4	[12.3	L,	3694.6	[12.4	Pt,
	3672.4	[13.9	L,	3694.7	[13.5	Wf,
	3673.6	[14.5	L,	3695.6	[12.4	O,
	3674.4	14.7	L,	3695.6	[13.9	Wf,
	3674.6	13.5	An,	3695.6	[12.4	Pt,
	3674.6	13.8	L,	3696.8	[13.9	Wf,
	3674.8	13.9	Wf,	3697.8	[12.4	Pt,
	3675.4	11.0	L,	3698.6	[12.6	Pt,
	3675.5	11.1	L,	3698.7	[12.6	Pt,
	3675.7	11.0	Wf,	3699.8	[12.4	M,
	3676.4	10.9	Lh,	3700.6	[14.5	Wf,
	3676.6	10.7	L,	3700.8	[12.6	Pt,
	3676.7	10.8	Wf,	3701.7	[12.4	Pi,
	3677.8	10.8	Wf,	3702.7	[12.6	Kl,
	3678.4	10.5	L,	3702.8	[12.6	Pt,
	3678.7	10.5	Wf,	3702.8	[14.5	Wf,
	3678.9	10.8	Br,	3703.7	[12.6	Pt,
	3679.4	10.5	L,	3705.6	[12.4	Pt,
	3679.7	10.8	Wf,	3707.7	[12.6	Kl,
	3682.4	10.8	L,	3709.5	[11.4	O,
	3684.9	11.6	Br,	3710.6	[11.4	Pi,
	3685.7	11.9	Wf,	3711.7	[11.0	Pi,
	3688.6	13.1	L,	3712.7	[12.6	Kl,
	3690.9	[13.0	Br,	3714.7	[11.8	Kl,
	3692.6	[13.9	Wf,	3723.7	[11.8	Kl.
061647 V AURIGAE—						
	3690.9	9.5	Br,	3709.6	10.0	O.
061702 V MONOCEROTIS—						
	3702.8	13.0	Pt.			
063308 R MONOCEROTIS—						
	3702.8	11.0	Pt.			
063558 S LYNCIS—						
	3699.7	14.2	Pt.			
064030 X GEMINORUM—						
	3692.9	8.6	Br.	3710.9	7.7	M.

VARIABLE STAR OBSERVATIONS, September 20 to October 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
064707 W MONOCEROTIS—						
	3702.8	10.8	Pt.			
064932 NOVA GEMINORUM #2—						
	3673.6	14.1	L.			
065208 X MONOCEROTIS—						
	3664.6	7.6	L,	3676.7	8.0	L.
065355 R LYNCIS—						
	3676.7	9.9	Wf,	3699.7	10.7	Pt,
	3690.8	10.0	Br,	3702.8	10.9	Wf.
	3694.7	10.6	Wf,			
070109 V CANIS MINORIS—						
	3678.9	9.2	Wf,	3710.9	8.7	M.
070122a R GEMINORUM—						
	3678.9	10.5	Wf,	3702.8	9.1	Wf,
	3679.9	10.5	Wf,	3702.8	8.6	Pt,
	3692.7	9.2	Ca,	3709.7	8.5	Ca.
	3699.8	8.6	M,			
070122b Z GEMINORUM—						
	3702.8	12.6	Pt.			
070122c TW GEMINORUM—						
	3699.8	8.8	M,	3709.7	8.1	Ca.
070310 R CANIS MINORIS—						
	3673.6	11.4	L,	3694.5	10.7	L.
071713 V GEMINORUM—						
	3702.8	8.7	Pt,	3710.9	8.7	M.
072708 S CANIS MINORIS—						
	3673.7	11.7	L,	3702.8	12.2	Pt.
	3694.6	12.0	L,			
072811 T CANIS MINORIS—						
	3678.9	11.1	Wf,	3702.8	10.4	Pt.
073173 S VOLANTIS—						
	3637.9	13.3	Bl,	3649.9	12.8	Bl.
073508 U CANIS MINORIS—						
	3664.6	11.7	L,	3702.8	10.2	Pt.
	3676.6	11.6	L,			
073723 S GEMINORUM—						
	3693.0	10.0	Br,	3702.8	10.3	Pt.
074241 W PUPPIS—						
	3639.3	8.2	Bl,	3655.3	8.8	Bl.
074323 T GEMINORUM—						
	3693.7	8.7	Br,	3702.8	8.9	Pt.
074922 U GEMINORUM—						
	3664.6	[13.3	L,	3688.6	[12.4	L,
	3670.6	[12.4	L,	3694.6	[13.3	L,
	3673.6	[13.7	L,	3697.8	[12.4	Pt,
	3674.6	13.8	L,	3700.8	[12.4	Pt,
	3675.6	[10.0	L,	3702.8	[13.7	Pt,
	3676.6	14.0	L,	3702.8	[13.7	Wf,
	3678.9	13.7	Wf,	3710.8	[12.4	M.
	3679.9	14.1	Wf,			
081112 R CANCRI—						
	3673.7	10.7	L,	3702.8	11.0	Pt.
	3694.6	11.2	L,			
081617 V CANCRI—						
	3702.8	10.2	Pt.			
082405 RT HYDRAE—						
	3676.7	7.9	L,	3702.8	7.7	Pt.
082476 R CHAMELEONTIS—						
	3635.9	8.6	Bl,	3656.9	8.8	Bl.
	3649.9	8.8	Bl,			
084803 S HYDRAE—						
	3702.8	8.6	Pt.			
085008 T HYDRAE—						
	3604.7	10.3	L.			
085120 T CANCRI—						
	3673.7	8.8	L,	3702.8	7.5	Pt.
091868 RW CARINAE—						
	3635.9	9.6	Bl,	3656.9	9.9	Bl.
	3649.9	9.8	Bl,			
092551 Y VELAE—						
	3637.9	12.7	Bl.			
092962 R CARINAE—						
	3635.9	9.1	Bl,	3656.9	9.1	Bl.
	3649.9	9.3	Bl,			
093178 Y DRACONIS—						
	3704.7	12.0	Br.			
093934 R LEONIS MINORIS—						
	3676.7	12.1	L.			
094211 R LEONIS—						
	3702.8	6.9	Pt,	3710.9	7.4	M.
094953 Z VELAE—						
	3637.9	12.6	Bl,	3655.3	13.3	Bl.
100661 S CARINAE—						
	3635.9	8.0	Bl,	3656.9	7.3	Bl.
	3649.9	7.8	Bl,			
101058 Z CARINAE—						
	3635.9	12.4	Bl,	3656.9	11.6	Bl.
	3649.9	12.0	Bl,			
101153 W VELAE—						
	3635.9	10.1	Bl,	3656.9	8.1	Bl,
	3649.9	8.9	Bl,			
103769 R URSAE MAJORIS—						
	3666.6	11.0	Kl,	3690.6	12.0	Kl,
	3670.7	11.3	Kl,	3692.6	11.8	Wf,
	3674.6	11.6	Kl,	3697.6	12.0	Kl,
	3675.6	11.6	Kl,	3698.6	11.9	Cd,
	3676.6	11.4	Kl,	3701.6	12.3	Wf,
	3676.7	11.5	Wf,	3702.8	12.0	Pt,
	3681.6	11.7	Kl,	3710.9	11.5	M.
104620 V HYDRAE—						
	3635.9	9.0	Bl,	3656.9	8.6	Bl.
	3649.9	8.9	Bl,			
104628 RS HYDRAE—						
	3635.9	10.5	Bl,	3656.9	9.7	Bl.
	3649.9	9.8	Bl,			
111561 RY CARINAE—						
	3635.9	11.3	Bl,	3653.9	11.4	Bl.
	3649.9	11.6	Bl,			
111661 RS CENTAURI—						
	3635.9	13.5	Bl.			
114441 X CENTAURI—						
	3637.9	12.8	Bl,	3656.9	12.2	Bl.
115058 W CENTAURI—						
	3635.9	8.9	Bl,	3656.9	8.1	Bl.
	3649.9	8.0	Bl,			
122854 U CENTAURI—						
	3635.9	8.6	Bl,	3656.9	8.1	Bl.
	3649.9	8.2	Bl,			

VARIABLE STAR OBSERVATIONS, September 20 to October 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
123160 T URSAE MAJORIS—						
	3670.7	12.3	Kl.	3693.6	12.7	Wf.
	3674.6	12.3	Kl.	3695.6	12.8	Pt.
	3675.6	12.4	Kl.	3701.6	12.7	Wf.
	3676.7	12.2	Wf.	3710.9	11.0	M.
123459 RS URSAE MAJORIS—						
	3676.7	10.9	Wf.	3701.6	8.6	Wf.
	3684.7	10.3	Br.	3701.6	8.7	Ca.
	3692.6	9.0	Wf.	3710.9	8.6	M.
	3695.6	9.0	Pt.			
123961 S URSAE MAJORIS—						
	3672.4	11.1	L.	3694.3	11.9	L.
	3674.4	10.8	An.	3695.6	11.8	Pt.
	3684.7	11.5	Br.			
131283 U OCTANTIS—						
	3635.9	11.3	Bl.	3656.9	10.0	Bl.
	3649.9	10.3	Bl.			
132122 R HYDRAE—						
	3635.9	8.7	Bl.	3656.9	9.0	Bl.
	3649.9	8.7	Bl.			
132155 RV CENTAURI—						
	3635.9	7.5	Bl.	3656.9	7.3	Bl.
	3649.9	7.5	Bl.			
133273 T URSAE MINORIS—						
	3676.7	12.4	Wf.	3701.6	13.1	Wf.
	3693.6	13.1	Wf.	3702.7	12.7	Br.
133633 T CENTAURI—						
	3635.9	7.9	Bl.	3656.9	7.0	Bl.
	3649.9	8.0	Bl.			
134236 RT CENTAURI—						
	3635.9	9.9	Bl.	3656.9	9.5	Bl.
	3649.9	9.7	Bl.			
134440 R CANUM VENATICORUM—						
	3695.6	11.3	Pt.			
134677 T APODIS—						
	3635.9	9.2	Bl.	3656.9	10.6	Bl.
	3649.9	9.8	Bl.			
140113 Z BOOTIS—						
	3676.7	9.7	Wf.	3692.6	10.1	Wf.
140528 RU HYDRAE—						
	3636.0	11.0	Bl.	3650.0	11.8	Bl.
140959 R. CENTAURI—						
	3635.9	8.1	Bl.	3656.9	8.2	Bl.
	3649.9	8.0	Bl.			
141567 U URSAE MINORIS—						
	3677.1	12.0	Ch.	3697.6	12.5	Fe.
	3684.7	12.3	Br.	3710.5	11.8	O.
	3695.6	12.4	Pt.			
141954 S BOOTIS—						
	3669.4	13.3	L.	3694.3	13.3	L.
	3676.7	13.1	Wf.	3695.6	13.1	Pt.
	3693.6	13.2	Wf.	3701.6	12.8	Wf.
142539 V BOOTIS—						
	3662.0	8.2	Kd.	3696.6	8.1	Cy.
	3667.0	8.1	Kd.	3699.5	7.8	Ly.
	3669.4	7.6	L.	3700.6	7.8	O.
	3685.5	7.4	Ca.	3701.7	7.6	Sg.
	3688.7	7.5	Sg.	3707.6	8.0	Fe.
	3691.6	7.4	Pt.	3708.5	7.8	Ca.
	3693.6	7.6	L.	3708.5	8.0	Ly.
	3694.5	7.6	Ly.	3709.5	8.2	Pi.
	3694.6	7.5	Fe.	3711.5	8.0	Ly.
142584 R CAMELOPARDALIS—						
	3676.7	9.3	Wf.	3700.6	8.6	Ca.
	3688.6	9.5	O.	3701.6	9.0	Wf.
	3693.6	9.0	Wf.	3701.7	9.3	Br
	3699.6	9.3	O.	3710.6	9.0	O.
143227 R BOOTIS—						
	3688.7	7.6	Sg.	3695.5	7.1	Ca.
	3691.6	7.0	Pt.	3701.7	6.9	Sg.
	3693.5	7.6	Ie.	3709.5	6.8	Ca.
145971 S APODIS—						
	3630.9	9.9	Bl.	3656.9	9.8	Bl.
	3650.0	9.7	Bl.			
150605 Y LIBRAE—						
	3669.3	9.4	L.			
151714 S SERPENTIS —						
	3672.3	8.4	L.	3694.3	8.9	L.
	3676.7	8.8	Wf.	3695.5	9.2	Ca.
	3692.6	8.7	Wf.	3701.6	9.5	Wf.
	3692.6	9.1	Pt.			
151731 S CORONAE BOREALIS—						
	3676.7	11.8	Wf.	3697.5	10.9	B.
	3692.6	11.5	Pt.	3701.5	10.8	M.
	3692.7	11.0	Sg.	3701.6	10.8	Wf.
	3693.6	11.6	Wf.	3703.7	11.6	Sg.
151822 RS LIBRAE—						
	3636.0	7.9	Bl.	3656.9	8.4	Bl.
	3650.0	8.2	Bl.	3690.3	9.8	L.
152849 R NORMAE—						
	3638.0	12.4	Bl.	3656.9	12.2	Bl.
	3650.0	12.6	Bl.			
153020 X LIBRAE—						
	3636.0	11.4	Bl.	3656.9	11.3	Bl.
	3650.0	11.2	Bl.			
153212 W LIBRAE—						
	3638.0	12.4	Bl.	3656.9	11.1	Bl.
	3650.0	11.3	Bl.			
153378 S URSAE MINORIS—						
	3609.0	8.8	Nk.	3692.7	11.0	Sg.
	3621.1	9.7	Nk.	3693.6	11.1	Wf.
	3674.0	10.5	Nk.	3696.6	11.4	Cy.
	3676.7	10.5	Wf.	3701.6	11.6	Wf.
	3690.5	10.8	Ro.	3701.6	11.6	Ca.
	3692.6	10.8	Pt.	3703.7	11.6	Sg.
154428 R CORONAE BOREALIS—						
	3603.0	7.5	Nk.	3691.5	6.0	Bi.
	3604.0	7.4	Nk.	3691.6	6.2	Wf.
	3608.0	7.4	Nk.	3691.6	6.5	Ft.
	3609.0	7.4	Nk.	3691.6	6.2	Pt.
	3619.1	7.3	Nk.	3692.5	6.1	Bi.
	3621.1	7.3	Nk.	3692.6	6.2	O.
	3630.0	6.6	Nk.	3692.6	6.3	Pt.
	3632.1	6.5	Nk.	3692.6	6.4	Cy.
	3637.0	6.2	Kd.	3692.6	6.3	Wf.
	3659.0	6.2	Kd.	3692.7	6.5	Sg
	3662.0	6.4	Kd.	3692.7	5.3	Ct.
	3664.0	6.1	Kd.	3693.3	6.3	An.
	3665.6	6.8	Kl.	3693.3	6.2	L.
	3666.6	6.7	Kl.	3693.3	6.3	Pe.
	3666.6	6.0	Ie.	3693.4	6.3	Lh.
	3667.0	6.2	Kd.	3693.5	6.3	Ca.
	3667.6	6.9	Kl.	3693.5	6.2	Bi.
	3669.1	6.3	Ch.	3693.6	6.3	Pt.

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Star	J.D.	Est.Obs.	J.D.	Est.Obs.
154428 R CORONAE BOREALIS—Cont.				
	3669.3	6.2 L,	3693.6	6.3 Wf,
	3669.3	6.4 An,	3694.3	6.0 L,
	3670.3	6.2 Pe,	3694.5	6.0 Lv,
	3670.3	5.4 Lh,	3694.5	6.4 Pt,
	3670.3	6.2 L,	3694.5	6.2 Bi,
	3670.7	6.9 Kl,	3694.6	6.2 O,
	3671.1	6.2 Ch,	3694.7	6.4 Wf,
	3671.3	6.1 L,	3695.5	6.3 Ca,
	3671.3	6.0 Lh,	3695.5	6.3 Pt,
	3671.6	6.9 Kl,	3695.6	6.8 Kl,
	3672.4	6.3 L,	3695.6	6.4 Wf,
	3673.1	6.2 Ch,	3695.6	6.5 Cd,
	3673.4	6.3 L,	3696.6	6.7 Kl,
	3673.6	6.8 Kl,	3696.6	6.2 Cy,
	3673.9	6.4 Kd,	3696.7	6.3 Wf,
	3674.3	6.3 An,	3697.5	6.4 Pt,
	3674.4	6.2 L,	3697.6	6.7 Kl,
	3674.6	6.7 Kl,	3698.6	6.8 Kl,
	3675.4	6.1 L,	3698.5	6.4 Pt,
	3675.5	6.0 Ie,	3699.5	6.3 Pt,
	3675.6	6.9 Kl,	3699.5	6.2 M,
	3675.7	6.3 Wf,	3699.6	6.5 O,
	3676.3	6.4 L,	3700.5	6.4 Ca,
	3676.4	6.5 Lh,	3700.5	6.7 Kl,
	3676.6	6.8 Kl,	3700.6	6.4 Fe,
	3676.7	6.2 Wf,	3700.7	6.5 Sg,
	3677.1	6.2 Ch,	3700.7	6.0 Ct,
	3676.6	6.2 Wf,	3700.7	6.3 Pt,
	3677.6	6.8 Kl,	3701.5	6.2 Pt,
	3678.4	6.2 L,	3701.6	6.7 Kl,
	3678.6	6.7 Kl,	3701.6	6.4 Ca,
	3678.9	6.1 Kd,	3701.6	6.4 Wf,
	3679.1	6.2 Wf,	3702.5	6.3 Pt,
	3679.7	6.2 Sg,	3702.6	6.7 Ft,
	3680.6	6.3 Cy,	3702.6	6.8 Kl,
	3681.6	6.3 Wf,	3702.7	5.2 Ct,
	3681.6	6.7 Kl,	3703.5	6.3 Pt,
	3684.3	6.3 Lh,	3703.7	6.5 Gb,
	3684.6	6.8 Kl,	3704.5	6.2 Pt,
	3684.9	6.2 Kd,	3704.6	6.8 Kl,
	3685.5	6.4 Ca,	3705.5	6.3 Pt,
	3685.6	6.7 Kl,	3706.5	6.0 Lv,
	3686.4	6.1 L,	3707.6	6.2 Fe,
	3686.6	6.7 Kl,	3708.5	6.4 Ca,
	3687.5	6.0 Ie,	3708.5	6.2 Pt,
	3687.6	6.2 Pt,	3709.5	6.2 Pi,
	3688.1	6.2 Ch,	3709.5	6.2 O,
	3688.5	6.4 Ca,	3710.5	6.5 Ca,
	3688.6	6.2 O,	3710.5	6.2 M,
	3688.6	6.2 Pt,	3711.5	6.4 Ca,
	3688.7	6.2 Sg,	3712.5	6.7 Kl,
	3689.3	6.2 L,	3713.6	6.7 Kl,
	3689.6	6.8 Kl,	3716.6	6.7 Kl,
	3690.3	6.3 L,	3721.5	6.7 Kl,
	3690.4	6.2 Lh,	3724.5	6.8 Kl.
154536 X CORONAE BOREALIS—				
	3691.6	8.9 Pt,	3697.5	9.0 B.
154615 R SERPENTIS—				
	3691.6	13.1 Pt.		
154639 V CORONAE BOREALIS—				
	3676.7	8.2 Wf,	3693.6	7.5 Wf,
	3685.6	7.0 Ca,	3695.5	7.0 Ca,
	3691.6	7.0 Pt,	3701.6	7.7 Wf.
155229 Z CORONAE BOREALIS—				
	3688.6	11.5 O,	3699.6	14.5 O.
160021 Z SCORPII—				
	3636.0	11.8 Bl,	3670.3	10.8 L,
	3650.0	10.9 Bl,	3670.3	10.7 Lh,
	3656.9	10.7 Bl,	3694.3	10.4 L.
160210 U SERPENTIS—				
	3609.1	12.0 Nk,	3701.6	11.3 Kl,
	3619.1	12.5 Nk,	3702.5	11.3 Kl,
	3621.1	12.8 Nk,	3712.5	10.6 Kl,
	3691.6	12.0 Pt,	3716.5	10.5 Kl.
	3692.6	11.8 Cy,		
160625a RU HERCULIS—				
	3670.3	13.1 L,	3693.6	12.8 Wf,
	3676.7	12.2 Wf,	3701.6	12.8 Wf,
	3691.6	13.5 Pt,	3706.6	13.4 B.
160625b SX HERCULIS—				
	3670.3	9.0 L,	3693.6	8.8 Pt,
	3675.7	9.5 Wf,	3695.5	8.3 Pt,
	3685.6	8.8 Wf,	3698.5	8.4 Pt,
	3691.6	8.9 Pt,	3701.6	8.0 Wf,
	3693.3	8.4 L,	3702.5	8.1 Pt,
	3693.4	8.3 Lh,	3704.5	8.0 Pt,
	3693.6	8.5 Wf,	3708.5	8.1 Pt.
161122a R SCORPII—				
	3638.0	11.7 Bl,	3656.9	10.8 Bl,
	3650.0	10.9 Bl,	3692.6	11.5 Pt.
161122b S SCORPII—				
	3638.0	13.0 Bl,	3692.6	11.4 Pt.
	3656.9	12.0 Bl,		
161138 W CORONAE BOREALIS—				
	3676.7	8.2 Wf,	3701.5	8.6 M,
	3692.6	7.8 Pt,	3701.5	8.3 Ya,
	3693.6	8.2 Wf,	3701.6	8.4 Wf,
	3697.5	8.0 B,	3702.7	9.6 Ct.
	3700.5	8.0 Ca,		
161607 W OPHIUCHI—				
	3670.3	14.5 L,	3692.6	12.0 Pt.
162112 V OPHIUCHI—				
	3677.1	9.4 Ch,	3692.6	8.7 Pt.
162119 U HERCULIS—				
	3676.7	11.6 Wf,	3693.6	11.8 Wf,
	3677.6	11.7 Ie,	3701.6	12.1 Wf,
	3692.6	11.7 Pt,	3706.6	11.9 B.
162319 Y SCORPII—				
	3670.3	11.4 L.		
162807 SS HERCULIS—				
	3672.4	11.5 L,	3694.3	12.1 L,
	3692.6	11.8 Pt,	3706.5	12.0 B.
162816 S OPHIUCHI—				
	3638.0	12.2 Bl.		
163137 W HERCULIS—				
	3685.6	9.4 Ca,	3701.5	10.0 M,
	3692.6	11.2 Pt,	3706.5	10.0 B,
	3696.6	10.6 Ya,	3711.5	9.7 Ca.
	3702.7	10.9 Ct,		

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Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
163172 R URSAE MINORIS—						
	3710.6	10.4	O.			
163266 R DRACONIS—						
	3669.1	8.3	Ch,	3692.6	9.4	Pt,
	3678.1	8.7	Ch,	3699.6	9.6	O,
	3684.7	8.9	Br,	3701.5	9.8	Pi,
	3685.6	8.9	Ca,	3701.6	10.2	Ya.
164319 RR OPHIUCHI—						
	3671.3	11.4	L,	3692.6	13.0	Pt.
164715 S HERCULIS—						
	3677.2	7.8	Ch,	3701.5	8.1	Ya,
	3688.5	7.2	Ca,	3708.5	7.3	Ca,
	3692.6	7.3	Pt,	3710.5	8.4	O,
	3693.6	8.0	O,	3710.5	8.0	Pi,
	3697.6	7.4	B,	3710.5	7.6	M.
	3700.5	7.3	Ca,			
164841 RS SCORPII—						
	3636.0	7.1	Bl,	3657.0	8.2	Bl.
	3650.0	7.7	Bl,			
165030 RR SCORPII—						
	3636.0	6.2	Bl,	3662.9	6.5	Kd,
	3650.0	5.6	Bl,	3663.9	6.5	Kd,
	3657.0	6.0	Bl,	3671.9	6.6	Kd.
	3658.9	6.1	Kd,			
165202 SS OPHIUCHI—						
	3692.6	13.5	Pt.			
165631 RV HERCULIS—						
	3632.1	11.5	Nk,	3695.5	14.0	Lv.
	3693.6	14.8	Pt,			
165636 RT SCORPII—						
	3636.0	10.6	Bl,	3657.0	11.0	Bl.
	3650.0	10.9	Bl,			
170215 R OPHIUCHI—						
	3666.1	7.1	Ch,	3685.5	7.1	Ca,
	3665.6	7.7	Kl,	3685.6	7.6	Kl,
	3666.6	7.3	Kl,	3686.6	7.8	Kl,
	3667.6	7.4	Kl,	3688.1	7.1	Ch,
	3670.6	7.5	Kl,	3689.6	7.8	Kl,
	3671.6	7.4	Kl,	3690.6	7.8	Kl,
	3673.5	7.0	Ie,	3692.6	7.5	Pt,
	3673.6	7.5	Kl,	3694.5	7.8	Ly,
	3674.6	7.5	Kl,	3695.6	8.2	Kl,
	3675.6	7.5	Kl,	3697.6	8.1	Kl,
	3676.6	7.5	Kl,	3699.5	8.1	Ly,
	3677.1	7.0	Ch,	3700.5	7.7	Ca,
	3677.6	7.4	Kl,	3700.6	7.9	Fe,
	3678.6	7.6	Kl,	3701.5	8.2	Kl,
	3681.6	7.7	Kl,	3702.5	8.0	Ly,
	3684.6	7.7	Kl,	3709.5	8.3	Ca,
	3685.1	7.0	Ch,	3716.5	8.6	Kl.
170627 RT HERCULIS—						
	3676.7	11.2	Wf,	3693.6	11.6	Wf,
	3688.6	11.6	O,	3697.6	12.1	B,
	3692.6	11.3	Pt,	3701.6	12.2	Wf.
171401 Z OPHIUCHI—						
	3692.6	10.5	Pt,	3697.6	10.0	B,
	3695.5	10.7	Ca,	3701.5	9.6	Ya.
171723 RS HERCULIS—						
	3608.2	8.3	Nk,	3685.0	10.0	Nk,
	3619.1	8.1	Nk,	3688.6	10.4	O,
	3621.1	8.3	Nk,	3692.6	10.5	Pt,
	3625.0	8.3	Nk,	3693.6	10.9	Wf,
	3632.0	8.3	Nk,	3696.6	11.0	O,
	3673.9	9.5	Nk,	3697.6	11.2	B,
	3676.7	9.4	Wf,	3701.6	11.7	Wf.
172486 S OCTANTIS—						
	3630.6	7.9	Bl,	3657.0	8.5	Bl.
	3650.0	8.0	Bl,			
172809 RU OPHIUCHI—						
	3704.6	13.0	B.			
173212 RS SERPENTIS—						
	3661.3	9.5	Lh,	3671.3	9.3	L.
173543 RV SCORPII—						
	3636.0	10.8	Bl,	3657.0	10.5	Bl.
	3650.0	10.6	Bl,			
174162 W PAVONIS—						
	3636.0	[13.5	Bl,	3657.0	10.2	Bl.
	3650.0	11.2	Bl,			
174406 RS OPHIUCHI—						
	3693.6	11.2	Pt.			
175519 RY HERCULIS—						
	3690.6	11.8	Lv,	3697.6	11.4	B,
	3693.6	11.6	Pt,	3710.5	10.4	Pi.
180531 T HERCULIS—						
	3670.3	8.9	L,	3693.6	8.5	Pt,
	3670.3	8.7	Lh,	3693.6	8.4	Wf,
	3670.3	8.5	Ch,	3695.6	8.0	Cd,
	3670.4	9.1	Pe,	3696.6	8.5	O,
	3673.6	8.7	Ie,	3696.6	8.4	Ya,
	3673.9	8.9	Nk,	3696.6	8.3	Ly,
	3675.7	8.5	Wf,	3699.6	8.0	Hu,
	3685.0	8.0	Nk,	3701.6	8.3	Wf.
	3685.6	8.4	Wf,	3701.7	8.5	Ct,
	3688.6	8.1	Pi,	3702.6	8.5	Ly,
	3690.3	8.5	Lh,	3708.5	8.3	Ca,
	3690.3	8.4	L,	3708.6	8.4	Ly,
	3692.7	8.4	Sg,	3710.5	8.4	Pi,
	3692.7	8.3	Ca,	3710.5	8.4	Cd.
	3693.3	7.6	Pe,			
180565 W DRACONIS—						
	3693.6	12.2	Pt,	3701.5	11.7	Pi,
	3695.6	11.9	Lv,	3710.6	11.2	O.
180911 NOVA OPHIUCHI #4—						
	3671.3	12.9	L,	3706.6	13.1	B.
	3693.6	13.0	Pt,			
181031 TV HERCULIS—						
	3670.3	9.8	Lh,	3690.3	10.5	L,
	3670.3	9.9	L,	3690.3	10.6	Lh,
	3670.4	10.2	Pe,	3693.3	11.2	Pe.
181103 RY OPHIUCHI—						
	3675.7	8.9	Wf,	3695.6	7.9	Lv,
	3685.7	8.0	Wf,	3697.6	7.7	B,
	3692.6	7.8	Wf,	3700.5	7.9	Ca,
	3693.6	7.9	Ca,	3701.6	8.0	Ya,
	3693.6	7.5	Pt,	3701.6	8.3	Wf.

VARIABLE STAR OBSERVATIONS, September 20 to October 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
181136 W LYRAE—						
	3672.4	8.4	L,	3694.3	9.1	L,
	3675.7	8.3	Wf,	3696.6	9.1	O,
	3685.7	8.6	Wf,	3699.6	8.9	Hu,
	3687.6	8.7	Pi,	3700.7	9.1	Ct,
	3692.7	8.5	Sg,	3701.6	9.7	Wf,
	3692.7	9.1	Ca,	3704.7	9.3	Ct,
	3692.7	9.2	Ct,	3704.8	9.3	Sg,
	3693.6	9.0	Wf,	3708.6	9.6	Pi,
	3693.6	8.6	Pt,	3711.6	9.3	Ca,
	3693.7	8.9	Ct.	3712.7	9.8	Ct.
182133 RV SAGITTARII—						
	3636.0	10.4	Bl,	3657.0	11.1	Bl.
	3650.1	11.1	Bl,			
182224 SV HERCULIS—						
	3670.3	10.7	L,	3693.6	9.7	Pt,
	3688.5	10.1	Pi,	3696.6	10.1	O,
	3692.6	10.1	O,	3697.6	10.1	B,
	3693.3	9.9	L,	3710.6	10.7	Pi.
	3693.3	9.9	Lh,			
182306 T SERPENTIS—						
	3704.6	12.3	B.			
183308 X OPHIUCHI—						
	3625.0	8.4	Nk,	3700.5	8.6	Ly,
	3670.4	8.6	L,	3700.6	8.2	Fe,
	3693.6	8.5	Pt,	3701.6	8.2	Ya,
	3694.6	8.2	Pi,	3704.6	8.5	B,
	3696.6	8.8	Ly,	3706.5	8.4	Ly,
	3697.5	8.4	B,	3708.5	8.3	Ly.
	3699.6	8.2	B,			
184205 R SCUTI—						
	3604.0	6.1	Nk,	3692.5	5.8	Ro,
	3619.1	5.9	Nk,	3692.6	5.6	Pt,
	3630.0	5.9	Nk,	3692.6	5.5	Ic,
	3631.1	5.8	Kd,	3692.6	5.8	O,
	3637.0	5.6	Kd,	3692.7	5.5	Sg,
	3658.1	5.3	Kd,	3692.7	5.3	Ct,
	3661.3	5.2	Lh,	3693.3	5.7	Pe,
	3662.0	5.3	Kd,	3693.3	5.8	An,
	3665.6	5.8	Kl,	3693.5	5.8	Ro,
	3666.6	5.7	Kl,	3693.6	5.7	Ca,
	3667.0	5.4	Kd,	3693.6	5.6	Pt,
	3667.6	5.6	Kl,	3693.7	5.3	Ct,
	3669.3	5.8	An,	3694.5	5.7	Pt,
	3669.4	5.8	Pe,	3694.6	5.7	Ya,
	3670.1	5.8	Ch,	3694.6	5.8	O,
	3670.4	5.8	Pe,	3695.5	5.5	Ie,
	3670.6	5.9	Kl,	3695.5	5.7	Pt,
	3671.0	5.7	Kd,	3695.5	5.7	Ca,
	3671.6	5.8	Kl,	3695.6	5.7	Cd,
	3672.3	5.5	Lh,	3695.6	5.7	Kl,
	3673.1	5.9	Ch,	3696.6	6.0	Cy,
	3673.4	6.0	An,	3696.6	5.7	Kl,
	3673.6	5.7	Kl,	3697.6	5.8	Pt,
	3673.9	5.7	Kd,	3697.6	5.8	Kl,
	3674.4	5.7	L,	3698.5	5.8	Pt,
	3674.6	5.8	Kl,	3698.6	5.8	Kl,
	3675.4	6.0	An,	3699.5	5.7	Pt,
	3675.5	5.5	Ie,	3699.6	5.6	O,
	3675.6	5.8	Kl,	3699.6	5.7	Ly,
	3676.6	5.9	Kl,	3700.5	5.5	Ly,
184205 R SCUTI—Continued.						
	3677.1	6.0	Ch,	3700.5	5.6	Ca,
	3677.6	5.8	Kl,	3700.6	5.6	Pt,
	3678.6	5.7	Kl,	3700.6	5.7	Kl,
	3678.9	5.7	Kd,	3700.7	6.0	Sg,
	3679.7	5.2	Sg,	3700.7	5.3	Ct,
	3680.7	5.8	Cy,	3701.5	5.6	Pt,
	3681.5	7.5	Ro,	3701.6	5.6	Ca,
	3681.6	5.7	Kl,	3701.6	4.8	M,
	3682.5	5.8	Ro,	3701.7	5.4	Ct,
	3684.6	5.7	Kl,	3702.5	5.6	Pt,
	3684.9	5.7	Kd,	3702.5	5.4	Ly,
	3685.6	5.7	Kl,	3702.6	5.7	Ft,
	3685.6	5.7	Ca,	3702.6	5.7	Kl,
	3687.6	5.8	Pt,	3703.5	5.8	Ro,
	3688.1	5.7	Ch,	3703.5	5.8	Pt,
	3688.4	5.6	L,	3704.5	5.7	Pt,
	3688.5	5.8	Ro,	3704.6	5.6	Kl,
	3688.5	5.6	Ca,	3704.7	5.4	Ct,
	3688.6	5.5	Pi,	3705.5	5.7	Pt,
	3688.6	5.9	Pt,	3705.6	5.7	Cd,
	3688.6	5.7	O,	3706.6	5.7	Ly,
	3689.0	5.7	Kd,	3708.4	5.7	Ca,
	3689.6	5.7	Kl,	3708.5	5.8	Pt,
	3689.7	5.5	Ct,	3710.5	5.6	Ca,
	3690.5	5.8	Ro,	3671.3	5.5	L,
	3690.5	5.7	Ly,	3712.5	5.5	Kl,
	3690.6	5.7	Kl,	3712.7	5.5	Ct,
	3690.6	5.6	Pt,	3713.6	5.5	Kl,
	3690.7	5.6	Ct,	3716.5	5.6	Kl,
	3691.6	5.6	Pt,	3721.5	5.7	Kl,
	3692.5	6.0	Cy,	3724.5	6.0	Kl.
184243 RW LYRAE—						
	3693.6	14.1	Pt.			
184300 NOVA AQUILAE #3—						
	3619.1	10.3	Nk,	3692.5	10.7	Ro,
	3661.3	10.3	Lh,	3692.7	10.1	Sg,
	3673.9	10.4	Nk,	3693.5	10.6	Ro,
	3673.4	10.3	L,	3693.5	10.1	Pi,
	3677.2	10.3	Ch,	3694.5	10.6	Ro,
	3681.5	10.6	Ro,	3695.5	10.7	Ro,
	3682.5	10.8	Ro,	3700.5	10.3	Ca,
	3685.0	10.0	Nk,	3701.6	10.2	M,
	3687.6	10.1	Pt,	3703.5	10.6	Ro,
	3688.5	10.7	Ro,	3706.6	10.3	B,
	3690.5	10.7	Ro,	3708.5	10.1	Pt.
185032 RX LYRAE—						
	3693.6	12.7	Pt,	3710.6	11.6	O.
185437 S CRUCIS AUS.—						
	3636.0	11.2	Bl.	3657.0	11.5	Bl.
	3650.1	11.5	Bl,			
185527a R CRUCIS AUS.—						
	3636.0	13.0	Bl.	3650.1	13.1	Bl.
185537b T CRUCIS AUS.—						
	3650.1	14.0	Bl.			
185634 Z LYRAE—						
	3669.4	13.8	L,	3693.6	13.6	Pt.
185737 RT LYRAE—						
	3702.6	11.7	O,	3708.6	10.8	Pi.

VARIABLE STAR OBSERVATIONS, September 20 to October 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
190108 R AQUILAE						
	3677.2	9.8	Ch,	3695.6	10.8	B,
	3693.6	11.2	Pt,	3700.5	11.5	Ca.
190529a V LYRAE						
	3693.6	13.4	Pt.			
190818 RX SAGITTARII						
	3704.6	12.1	B.			
*190819*a RW SAGITTARII						
	3676.2	10.0	Ch,	3704.6	10.2	B.
	3693.6	9.8	Pt,			
190907 TY AQUILAE						
	3693.6	10.7	Pt.			
190925 S LYRAE						
	3669.4	12.5	L,	3694.6	13.2	Pt,
	3690.6	12.9	Lv,	3694.6	13.0	B,
	3694.3	13.0	L,	3697.6	13.0	Lv.
190926 X LYRAE						
	3694.6	9.0	Pt.			
190933a RS LYRAE						
	3678.2	11.2	Ch,	3695.6	11.9	Lv,
	3694.6	11.8	Pt,	3702.6	11.8	O.
190941 RU LYRAE						
	3708.6	11.7	Pi.			
190967a U DRACONIS						
	3668.2	11.9	Ch,	3694.6	9.8	Pt,
	3677.2	10.8	Ch,	3701.6	9.2	Pi,
	3684 8	10.1	Br,	3710.6	9.3	O.
	3691.5	10.0	Pi,			
191017 T SAGITTARII						
	3676.2	9.9	Ch,	3694.6	11.4	Pt.
191019 R SAGITTARII						
	3692.7	10.6	Sg,	3695.5	9.9	Ca,
	3694.6	10.3	Ya,	3704.6	9.5	B,
	3694.6	10.0	Pt,	3704.7	9.9	Ct.
191033 RY SAGITTARII						
	3636.0	9.8	Bl,	3691.6	11.9	Pt,
	3638.0	9.7	Bl,	3692.6	11.5	Pt,
	3657.0	9.7	Bl,	3693.3	10.4	L,
	3661.3	9.6	Lh,	3693.3	10.5	Lh,
	3666.1	10.0	Ch,	3693.6	11.4	Pt,
	3669.3	10.4	L,	3694.3	10.3	L,
	3670.3	10.3	L,	3694.5	11.4	Pt,
	3670.3	10.0	Lh,	3695.5	11.3	Pt,
	3671.1	11.2	Ch,	3697.5	11.1	Pt,
	3671.3	10.3	L,	3698.5	11.1	Pt,
	3671.3	9.6	Lh,	3699.5	11.2	Pt,
	3672.3	10.7	L,	3701.5	11.1	Pt,
	3674.3	10.7	L,	3702.5	11.0	Pt,
	3674.3	9.6	An,	3703.5	11.2	Pt,
	3676.3	10.9	L,	3704.5	11.2	Pt,
	3689.3	10.3	L,	3705.5	11.4	Pt.
	3689.3	10.2	Lh,			
191319 S SAGITTARII						
	3636.0	10.9	Bl,	3694.6	13.5	Pt.
	3650.1	11.6	Bl,			
191331 SW SAGITTARII						
	3636.0	10.6	Bl,	3657.0	11.5	Bl.
	3650.1	11.5	Bl,			
191350 TZ CYGNI						
	3687.6	10.7	Pi,	3708.6	11.1	Pi,
	3694.6	10.6	Pt,			
191637 U LYRAE						
	3694.6	11.2	Pt,	3701.6	10.8	M.
192928 TY CYGNI						
	3676.2	11.1	Ch,	3701.6	9.5	M.
	3694.6	9.9	Pt,			
193311 RT AQUILAE						
	3666.1	11.0	Ch,	3694.6	11.9	Pt,
	3692.6	10.5	O,	3695.7	12.0	B.
193449 R CYGNI						
	3665.6	8.6	Kl,	3700.6	10.2	Kl,
	3667.6	9.3	Kl,	3700.7	9.7	Sg,
	3670.7	9.6	Kl,	3701.6	10.1	Kl,
	3673.2	9.6	Ch,	3701.6	9.1	M,
	3675.6	9.9	Kl,	3701.6	9.8	Ya,
	3676.7	9.2	Wf,	3701.7	10.0	Ct,
	3684.7	9.7	Kl,	3702.6	9.9	Ly,
	3687.6	9.3	Pi,	3702.7	10.1	Kl,
	3687.7	8.9	Ca,	3704.6	10.4	Kl,
	3689.6	9.9	Kl,	3706.6	9.7	B,
	3692.5	9.8	Cy,	3706.6	9.7	Ly,
	3695.5	9.9	Kl,	3706.7	10.2	Lv,
	3695.6	10.0	Lv,	3707.7	10.4	Kl,
	3696.6	9.8	Cy,	3708.5	10.2	Pi,
	3697.6	9.8	Kl,	3709.7	9.8	Ca,
	3697.7	10.0	Ke,	3712.7	10.4	Kl,
	3698.6	9.6	Pt,	3723.7	11.0	Kl.
	3699.6	9.2	Hu,			
193509 RV AQUILAE						
	3698.6	13.3	Pt.			
193732 TT CYGNI						
	3699.6	7.0	Hu.			
193972 T PAVONIS						
	3636.0	12.1	Bl,	3657.0	13.2	Bl.
194048 RT CYGNI						
	3673.2	7.5	Ch,	3700.7	8.4	Sg,
	3692.7	8.0	Ca,	3701.6	8.5	M,
	3697.8	8.3	Ke,	3701.7	8.5	Ct,
	3698.6	8.3	Pt,	3706.6	8.7	B,
	3699.6	8.6	Hu,	3709.7	8.7	Ca.
194348 TU CYGNI						
	3673.2	9.1	Ch,	3701.6	9.8	M,
	3692.8	9.3	Br,	3701.7	10.2	Ct,
	3695.6	9.4	Lv,	3706.6	9.2	B,
	3698.6	9.1	Pt,	3706.7	9.6	Lv.
	3699.6	9.8	Hu,			
194604 X AQUILAE						
	3675.7	14.5	Wf,	3694.7	13.3	B,
	3692.6	14.3	Wf,	3701.6	13.8	Wf.
194632 χ CYGNI						
	3662.0	8.3	Kd,	3693.3	6.3	Pe,
	3666.0	8.2	Ch,	3693.7	6.1	Ct,
	3669.3	7.9	An,	3693.7	6.2	Ct,
	3669.4	8.1	Pe,	3694.6	6.3	Ya,
	3670.4	8.1	Pe,	3695.6	5.8	Ca,
	3672.0	8.0	Kd,	3698.6	6.0	Pt,
	3673.9	8.1	Nk,	3699.6	5.5	Hu,
	3676.2	7.3	Ch,	3700.7	5.8	Ct,
	3680.0	7.1	Kd,	3701.6	6.0	M,
	3683.3	6.2	An,	3701.7	5.9	Ct,
	3685.0	7.0	Nk,	3704.7	5.6	Ct,
	3686.2	6.6	Ch,	3706.6	6.5	B,

VARIABLE STAR OBSERVATIONS, September 20 to October 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
194632 χ CYGNI—Continued.						
	3687.7	6.8	Ca.	3708.5	5.2	Ca.
	3688.2	6.4	Ch.	3710.6	5.3	Pi.
	3688.5	6.7	Pi.	3612.7	5.1	Ct.
	3689.0	6.5	Kd.			
194939 RR SAGITTARII						
	3638.0	12.0	Bl.	3657.0	11.5	Bl.
	3650.1	11.8	Bl.			
195142 RU SAGITTARII						
	3636.0	7.6	Bl.	3657.0	6.9	Bl.
	3650.1	6.8	Bl.			
195205 RR AQUILAE						
	3693.5	12.2	Pi.	3698.6	12.0	Pt.
	3694.7	12.3	B.			
195308 RS AQUILAE						
	3690.7	9.2	Br.	3698.6	9.4	Pt.
	3693.5	9.8	Pi.	3700.6	9.5	Ca.
	3696.6	9.1	B.			
195553 NOVA CYGNI No. 3						
	3609 1	10.5	Nk.	3692.6	11.0	Pt.
	3673.6	11.0	L.	3694.6	10.8	Ya.
	3676.6	11.1	L.	3698.6	11.0	Pt.
	3678.3	10.9	Ch.	3708.5	10.9	Pt.
	3685.0	11.5	Nk.	3709.7	10.9	Ca.
	3688.6	10.9	Pt.	3711.7	11.0	Pt.
195849 Z CYGNI						
	3677.6	12.7	Wf.	3701.6	10.5	M.
	3692.6	11.1	Wf.	3702.7	10.8	Wf.
	3698.6	10.2	Pt.	3706.6	9.9	B.
195855 S TELESCOPII						
	3638.0	12.9	Bl.			
200212 SY AQUILAE						
	3670.4	13.4	L.	3698.6	13.2	Pt.
	3677.6	13.7	Wf.	3700.6	13.9	Wf.
	3692.6	14.0	Wf.			
200357 S CYGNI						
	3675.7	14.7	Wf.	3695.6	13.4	Lv.
	3692.6	14.0	Wf.	3701.6	13.6	Wf.
200514 R CAPRICORNI						
	3698.6	13.0	Pt.			
200715a S AQUILAE						
	3675.7	12.0	Wf.	3696.6	11.9	B.
	3685.7	11.9	Wf.	3698.6	11.6	Pt.
	3688.5	11.8	Pi.	3701.6	10.0	M.
	3692.6	11.8	Wf.	3701.7	11.9	Wf.
	3692.6	11.8	O.			
200715b RW AQUILAE						
	3692.6	9.4	O.	3696.6	9.2	B.
	3696.6	9.0	Ya.	3698.6	9.1	Pt.
200747 R TELESCOPII						
	3636.0	13.5	Bl.	3650.1	14.0	Bl.
200812 RU AQUILAE						
	3677.6	13.9	Wf.	3697.7	13.1	Lv.
	3696.6	13.2	B.	3701.7	13.2	Wf.
	3697.6	13.4	Wf.			
200822 W CAPRICORNI						
	3698.6	11.5	Pt.			
200906 Z AQUILAE						
	3690.7	9.5	Br.	3698.6	9.1	Pt.
200916 R SAGITTAE						
	3696.6	9.5	Ya.			
200938 RS CYGNI						
	3671.2	8.8	Ch.	3700.7	7.0	Sg.
	3671.3	8.2	L.	3702.6	8.2	Ly.
	3674.4	9.2	An.	3703.8	7.8	Ke.
	3679.2	8.8	Ch.	3706.6	8.2	Ly.
	3698.6	7.5	Pt.			
201008 R DELPHINI						
	3671.3	12.2	L.	3694.6	12.8	Wf.
	3674.6	13.1	Ie.	3698.6	13.0	Pt.
	3677.6	12.8	Wf.	3701.7	12.7	Wf.
	3690.7	12.9	Br.	3704.6	12.7	B.
	3692.6	13.1	Ie.			
201121 RT CAPRICORNII						
	3637.0	7.4	Kd.	3673.4	6.3	L.
	3662.0	7.4	Kd.	3679.0	7.3	Kd.
	3667.0	7.3	Kd.	3698.6	6.4	Pt.
201130 SX CYGNI						
	3667.6	12.5	Wf.	3669.7	13.4	B.
	3693.6	13.0	Br.	3701.6	13.0	M.
	3694.6	13.2	Wf.	3701.7	13.4	Wf.
201130 RT SAGITTARII						
	3636.0	11.9	Bl.	3657.0	10.8	Bl.
	3650.1	10.9	Bl.	3697.5	9.5	Pt.
201437b WX CYGNI						
	3665.6	10.6	Kl.	3695.7	10.3	Lv.
	3667.6	10.3	Kl.	3697.6	10.4	Kl.
	3670.7	10.4	Kl.	3698.6	19.8	Pt.
	3671.2	10.5	Ch.	3700.5	10.5	Kl.
	3675.6	10.4	Kl.	3700.7	10.4	Lv.
	3677.6	10.6	Wf.	3701.7	10.4	Wf.
	3679.2	10.3	Ch.	3701.7	9.0	Sg.
	3681.6	10.4	Kl.	3706.6	9.1	B.
	3684.7	9.8	Kl.	3712.7	10.4	Kl.
	3689.6	10.0	Kl.	3714.7	10.4	Kl.
	3691.7	10.5	Br.	3772.3	10.7	Kl.
	3694.6	10.3	Wf.			
201647 U CYGNI						
	3681.5	7.8	Ro.	3698.6	7.8	Pt.
	3690.5	7.8	Ro.	3701.6	8.2	M.
	3692.5	7.8	Ro.	3701.7	9.8	Ct.
	3692.7	8.0	Ca.	3702.8	7.8	Sg.
	3693.7	9.0	Ct.	3703.5	7.9	Ro.
	3694.5	8.0	Ya.	3706.6	8.0	B.
	3695.5	7.9	Ro.			
202240 U MICROSCOPII						
	3638.0	13.4	Bl.			
202817 Z DELPHINI						
	3677.7	13.4	Wf.	3700.6	12.0	Lv.
	3691.7	12.8	Br.	3701.7	12.4	Wf.
	3694.6	12.9	Wf.	3604.6	12.7	B.
	3696.7	12.5	B.	3706.7	11.9	Lv.
	3698.6	13.0	Pt.			
202946 SZ CYGNI						
	3688.6	9.7	Pt.	3701.5	9.8	Pt.
	3691.6	9.1	Pt.	3703.5	9.9	Pt.
	3693.6	8.8	Pt.	3708.5	9.1	Pt.
	3695.5	8.9	Pt.	3711.7	8.8	Pt.
	3697.5	9.0	Pt.			

VARIABLE STAR OBSERVATIONS, September 20 to October 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
202954 ST CYGNI						
	3677.7	13.2	Wf,	3698.6	13.4	Pt,
	3691.7	13.5	Br,	3701.7	12.8	Wf,
	3694.6	12.9	Wf,	3706.7	10.3	B.
203226 V VULPECULAE						
	3698.6	8.7	Pt.			
203429 R MICROSCOPII						
	3636.0	9.0	Bl,	3657.0	10.9	Bl.
	3650.1	10.6	Bl,			
203611 Y DELPHINI						
	3677.7	13.6	Wf,	3701.7	13.5	Wf,
	3694.6	13.6	Wf,	3704.6	13.4	B.
	3698.6	14.0	Pt,			
203816 S DELPHINI						
	3674 0	9.0	Nk,	3698.6	9.2	Pt,
	3685.0	9.2	Nk,	3701.6	9.4	M.
203847 V CYGNI						
	3676.2	10.6	Ch.	3701.7	9.5	Ct.
	3677.7	10.4	Wf,	3701.7	9.4	Wf,
	3694.6	9.7	Wf,	3706.6	8.0	B,
	3697.7	9.5	Lv,	3710.7	8.2	Ca,
	3699.5	7.5	Pt,			
203905 Y AQUARII						
	3692.6	10.4	B,	3695.6	11.0	Ya,
	3692.7	11.0	Sg,	3699.5	11.2	Pt,
	3693.5	11.1	Pi,	3705.6	11.6	Br.
	3693.7	11.0	Br,			
204016 T DELPHINI						
	3674.0	12.1	Nk,	3696.5	9.6	Pi,
	3685.0	10.1	Nk,	3699.5	9.4	Pt,
	3691.7	9.4	Br,	3704.6	8.9	B,
	3692.7	9.5	Sg,	3704.8	9.0	Sg.
204102 V AQUARII						
	3694.5	9.6	B,	3695.6	9.5	Ya,
	3694.6	9.0	Pi,	3699.5	9.0	Pt.
204104 W AQUARII						
	3669.4	12.3	L,	3692.7	13.0	Br.
	3674.0	12.4	Nk,			
204215 U CAPRICORNI						
	3638.0	14.0	Bl,	3692.7	11.9	Br.
	3692.5	12.3	B,	3699.5	12.3	Pt.
204405 T AQUARII						
	3694.6	13.8	B.	3699.5	14.4	Pt.
204846 RZ CYGNI						
	3677.7	12.2	Wf,	3699.5	13.0	Pt,
	3678.7	12.3	Br,	3701.6	12.0	Br,
	3694.6	12.2	Wf,	3701.7	12.0	Wf.
	3697.8	12.1	Lv,			
205017 X DELPHINI						
	3677.7	13.8	Wf,	3700.7	14.0	Wf.
	3694.6	14.0	Wf,			
205923 R VULPECULAE						
	3675.7	13.3	Wf,	3699.5	10.3	Pt,
	3685.7	12.0	Wf,	3699.6	10.0	Hu,
	3691.7	11.8	Br,	3700.7	9.7	Lv,
	3693.6	11.3	Wf,	3701.6	10.2	M,
	3694.7	11.2	Wf,	3701.7	10.1	Wf.
	3695.7	12.2	Wf,			
210124 V CAPRICORNI						
	3636.0	12.3	Bl.			
210129 TW CYGNI						
	3677.7	11.9	Wf,	3694.7	12.2	Wf,
	3691.8	12.2	Br,	3702.9	12.0	Wf.
210382 X CEPHEI						
	3677.7	14.1	Wf.			
210504 RS AQUARII						
	3669.4	11.7	L,	3694.6	11.0	B,
	3693.3	10.7	L,	3699.5	10.4	Pt.
210516 Z CAPRICORNI						
	3694.6	10.5	Pi,	3699.5	10.7	Pt,
	3695 5	10.4	B,	3699.6	10.9	O.
210812 R EQUULEI						
	3677.7	9.1	Wf,	3699.5	10.0	Pt,
	3694.7	9.5	Wf,	3702.8	9.9	Wf,
	3695.5	9.5	B,	3710.6	10.9	Pi.
210868 T CEPHEI						
	3665.6	8.1	Kl,	3689.6	8.9	Kl.
	3666.1	8.6	Ch,	3694.5	8.7	Pt.
	3666.6	8.2	Kl,	3695.6	9.4	Kl,
	3670.4	8.3	L,	3697.6	9.7	Kl,
	3673.6	8.3	Kl,	3698.6	9.7	Kl,
	3674.6	8.3	Kl,	3699.6	9.7	Pi,
	3675.6	8.4	Kl,	3700.6	9.6	Kl,
	3677.6	8.3	Kl,	3701.6	9.8	Pi,
	3679.7	8.6	Sg,	3701.7	9.0	Sg,
	3681.6	8.5	Kl,	3702.6	9.5	Kl,
	3684.6	8.6	Kl,	3707.7	9.7	Kl.
	3685.2	9.0	Ch,	3712.7	9 8	Kl.
210903 RR AQUARII						
	3694.6	9.8	B,	3694.6	10.3	Pi.
	3694.6	10.0	Pt,			
211614 X PEGASI						
	3675.7	14.3	Wf,	3695.6	13.5	B
	3692.6	13.9	Wf,	3701.7	13.7	Wf,
	3692.7	14.0	Br,	3705.7	12.3	Br.
211615 T CAPRICORNI						
	3636.0	8.8	Bl,	3692.6	11.7	B
	3650.1	9.5	Bl,	3692.7	12.0	B.,
	3657.0	9.9	Bl,	3694.5	12.4	Pt.
	3671.1	10.8	Ch,			
212030 S MICROSCOPII						
	3638.0	12.8	Bl.			
212814 Y CAPRICORNI						
	3694.5	12.6	Pt,	3699.6	12.7	O.
	3694.6	12.7	B,			
213244 W CYGNI						
	3631.1	6.4	Kd,	3671.0	6.1	Kd,
	3637.0	6.4	Kd,	3673.9	6.3	Nk,
	3658.1	6.4	Kd,	3674.4	5.7	L,
	3660.4	5.4	An,	3685.0	6.3	Kd,
	3662.0	6.2	Kd,	3693.3	6.3	An.
	3664.6	5.7	L,			
213678 S CEPHEI						
	3677.7	9.6	Wf,	3694.7	9.7	Wf,
	3693.7	9.5	Br,	3699.6	9.9	Pi.
	3694.5	8.5	Pt,	3700.6	9.8	Lv.
213753 RU CYGNI						
	3678.3	8.3	Ch,	3694.5	8.1	Pt.
213843 SS CYGNI						
	3603.1	8.9	Nk,	3690.3	8.6	L,
	3604.1	9.0	Nk,	3690.5	8.5	Ro,

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Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
213843 SS CYGNI—Continued						
	3608.1	10.3	Nk,	3690.5	8.2	Ly,
	3619.1	11.5	Nk,	3690.6	8.3	Kl,
	3621.1	11.9	Nk,	3690.7	8.5	Br,
	3625.1	11.9	Nk,	3691.5	8.3	Pi,
	3630.0	11.8	Nk,	3691.5	8.4	Ie,
	3631.0	10.7	Nk,	3691.6	8.6	Pt,
	3632.0	8.8	Nk,	3691.6	8.7	Wf,
	3661.2	[10.9	Ch,	3691.6	8.5	Br,
	3661.3	11.6	Lh,	3691.6	8.6	Fe,
	3662.3	11.2	Lh,	3691.7	8.6	B,
	3664.2	[10.9	Ch,	3692.5	8.5	Ro,
	3664.6	11.7	L,	3692.5	8.8	Ca,
	3665.2	[10.9	Ch,	3692.6	8.8	Pt,
	3665.6	11.2	Kl,	3692.6	8.8	Wf,
	3666.1	11.7	Ch,	3692.6	8.6	Ie,
	3666.6	11.3	Kl,	3692.6	8.2	O,
	3667.6	11.2	Kl,	3692.6	8.6	Br,
	3668.1	11.7	Ch,	3692.7	8.6	B,
	3669.1	11.7	Ch,	3693.3	8.9	Lh,
	3669.3	11.4	L,	3693.3	8.7	L,
	3669.3	11.1	Lh,	3693.5	8.7	Ro,
	3670.1	11.7	Ch,	3693.5	8.5	Pi,
	3670.3	11.4	Lh,	3693.5	8 8	Ca,
	3670.3	11.4	L,	3693.5	9.1	Pt,
	3670.6	11.5	Kl,	3693.6	8.2	O,
	3671.1	11.7	Ch,	3693.6	8.6	Wf,
	3671.3	11.5	L,	3693.6	8.8	Br,
	3671.3	11.5	Lh,	3693.7	8.2	Ct,
	3671.3	11.3	Kl,	3694.3	9.0	L,
	3672.3	11.4	L,	3694.5	8.8	Ro,
	3673.1	[10.9	Ch,	3694.5	8.9	Ya,
	3673.4	11.2	L,	3694.5	9.1	Pt,
	3673.6	11.3	Kl,	3694.6	8.2	O,
	3673.6	11.4	Kl,	3694.6	8.6	Pi,
	3673.6	11.6	L,	3694.6	8.4	Ly,
	3674.0	12.0	Nk,	3694.6	9.1	L,
	3674.3	11.2	L,	3694.6	8.5	Fe,
	3674.3	11.1	An,	3694.7	8.8	Wf,
	3674.6	11.3	Kl,	3694.7	8.8	B,
	3674.6	11.5	L,	3695.5	9.4	Gd,
	3674.8	11.8	Wf,	3695.5	9.5	Pi,
	3675.0	12.0	Nk,	3695.5	9.0	Ro,
	3675.4	11.4	L,	3695.5	8.9	Ca,
	3675.6	11.1	Kl,	3695.6	9.6	Pt,
	3675.7	11.9	Wf,	3695.5	8.9	Kl,
	3676.1	[10.9	Ch,	3695.6	9.2	Cd,
	3676.4	11.4	Lh,	3695.6	8.6	O,
	3676.6	11.7	L,	3695.6	8.8	Wf,
	3676.6	10.9	Kl,	3695.7	9.2	Lv,
	3676.7	11.8	Wf,	3695.7	9.1	B,
	3677.1	11.8	Ch,	3696.5	8.7	Ly,
	3677.6	11.1	Kl,	3696.5	9.6	Pi,
	3677.7	11.6	Br,	3696.6	9.5	O,
	3677.7	11.8	Wf,	3696.6	9.0	Kl,
	3677.8	11.6	Br,	3696.7	9.7	B,
	3678.1	[10.9	Ch,	3696.8	9.1	Wf,
	3678.4	11.4	Lh,	3697.5	9.8	Pt,
	3678.4	11.5	L,	3697.6	9.4	Kl,
	3678.6	11.0	Kl,	3697.6	9.9	Fe,
	3678.7	11.7	Br,	3697.7	9.6	Lv,
	3678.7	11.6	Wf,	3697.7	9.8	B,
	3679.0	11.5	Br,	3698.5	9.9	Cd,
	3679.2	[10.9	Ch,	3698.5	9.8	Kl,
	3679.4	10.9	L,	3698.5	10.0	Pt,
	3679.4	11.0	Lh,	3698.6	10.3	Fe,
	3679.6	10.9	Ie,	3698.6	10.2	Pi,
	3679.7	10.9	Wf,	3699.5	10.6	Pi,
	3679.7	10.6	Sg,	3699.5	10.5	Ly,
	3679.7	11.0	Br,	3699.5	10.3	Pt,
	3679.9	10.4	Wf,	3699.6	10.6	Hu,
	3680.0	10.8	Nk,	3699.7	10.7	Br,
	3680.5	10.0	Ro,	3700.5	10.9	Ly,
	3680.7	9.6	Wf,	3700.5	10.4	Kl,
	3680.7	9.9	Br,	3700.5	11.2	Ca,
	3681.5	9.4	Ro,	3700.6	10.4	Kl,
	3681.6	9.5	Kl,	3700.6	11.0	Wf,
	3681.6	9.3	Wf,	3700.6	11.0	Br,
	3682.1	8.9	Ch,	3700.6	10.8	Fe,
	3682.4	9.0	L,	3700.7	11.0	Lv,
	3682.5	9.0	Ie,	3700.7	10.8	Sg,
	3682.5	8.5	Ly,	3700.8	11.0	Pt,
	3682.5	9.2	Cd,	3701.5	11.1	Pi,
	3682.5	8.9	Ro,	3701.5	10.9	Kl,
	3682.6	8.8	O,	3701.5	11.6	Pt,
	3683.2	8.8	Ch,	3701.6	11.5	M,
	3683.5	8.5	Ro,	3701.6	10.5	Fe,
	3684.6	8.3	Kl,	3701.6	11.5	Br,
	3684.7	8.5	Br,	3701.6	11.0	Ya,
	3685.0	8.4	Nk,	3701.7	11.1	Wf,
	3685.1	8.3	Ch,	3702.5	11.6	Pt,
	3685.5	8.5	Ca,	3702.5	11.4	Kl,
	3685.6	8.2	Kl,	3702.6	[11.3	Ly,
	3685.6	8.3	Br,	3702.6	11.9	Br,
	3685.7	8.3	Wf,	3702.6	11.6	Fe,
	3686.0	8.3	Nk,	3702.7	11.4	Kl,
	3686.2	8.3	Ch,	3702.7	11.6	Wf,
	3686.3	8.5	L,	3703.5	11.8	Pt,
	3686.4	8.4	Lh,	3703.5	11.5	Ro,
	3686.6	8.1	Kl,	3704.5	11.4	Kl,
	3687.2	8.3	Ch,	3704.5	11.9	Pt,
	3687.5	8.4	Cd,	3704.6	11.9	Br,
	3687.5	8.4	Ie,	3704.7	11.6	B,
	3687.6	8.2	Pi,	3705.5	11.9	Pt,
	3687.6	8.3	Pt,	3705.6	11.7	Cd,
	3687.7	8.6	Ca,	3705.6	11.9	Br,
	3688.1	8.3	Ch,	3706.5	11.8	Pi,
	3688.4	8.6	Lh,	3706.7	11.6	B,
	3688.4	8.5	L,	3707.6	11.9	Fe,
	3688.5	8.4	Ie,	3707.7	11.7	Kl,
	3688.5	8.2	Pi,	3708.5	11.8	Pt,
	3688.6	8.4	L,	3709.6	11.8	Hu,
	3688.6	8.2	Ca,	3709.7	11.8	Ca,
	3688.6	8.2	O,	3710.5	11.7	Cd,
	3689.3	8.6	L,	3710.7	11.7	Ca,
	3689.3	8.5	Lh,	3711.7	11.6	Pt,
	3689.5	8.0	Ly,	3712.7	11.5	Kl,
	3689.6	8.4	Kl,	3714.7	11.4	Kl,
	3689.7	8.6	Wf,	3723.7	11.9	Kl,
	3689.7	8.4	Br,	3724.6	11.5	Kl,
	3690.3	8.6	Lh,			

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Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
213937 RV CYGNI						
	3694.5	6.4	Pt,	3699.6	7.0	Hu.
214024 RR PEGASI						
	3677.7	10.9	Wf,	3694.7	11.6	Wf,
	3691.8	11.2	Br,	3702.8	11.9	Wf,
	3694.5	11.6	Pt,	3705.7	12.3	Br.
214247 R GRUIS						
	3636.0	12.3	Bl,	3657.0	10.9	Bl.
	3650.1	11.8	Bl,			
215605 Y PEGASI						
	3677.7	10.0	Wf,	3699.6	10.2	O,
	3694.5	10.2	Pt,	3702.8	10.4	Wf,
	3694.7	10.2	Wf,	3704.6	10.7	Br.
	3697.7	10.4	Lv,			
215717 U AQUARII						
	3692.7	11.8	Br,	3694.6	11.5	B.
	3694.5	11.8	Pt,			
215934 RT PEGASI						
	3691.8	11.0	Br,	3695.7	13.5	Lv,
	3693.7	11.1	Sg,	3705.7	11.3	Br.
	3694.5	11.1	Pt,			
220133a RY PEGASI						
	3694.5	12.0	Pt.			
220133b RZ PEGASI						
	3694.5	11.2	Pt.			
220412 T PEGASI						
	3671.4	13.5	L.			
220714 RS PEGASI						
	3677.7	10.2	Br,	3694.6	10.0	O,
	3693.7	9.7	Br,	3695.6	9.3	B,
	3694.5	9.4	Pt,	3697.7	10.2	Lv.
222129 RV PEGASI						
	3692.6	9.9	B,	3704.7	10.4	Br.
222439 S LACERTAE						
	3672.4	8.2	L,	3694.3	9.1	L,
	3679.7	8.0	Ie,	3694.5	8.6	Pt,
	3688.5	8.9	Pi,	3696.7	9.2	Lv.
	3691.8	8.4	Br,			
222867 R INDI						
	3638.0	9.2	Bl,	3657.0	9.1	Bl.
	3650.1	9.2	Bl,			
223841 R LACERTAE						
	3670.4	14.8	L.			
225120 S AQUARII						
	3704.6	11.9	B.			
225914 RW PEGASI						
	3692.6	13.6	B,	3694.6	14.5	Pt.
230110 R PEGASI						
	3677.7	13.0	Br,	3694.6	13.0	Pt.
230759 V CASSIOPEIAE						
	3677.7	13.4	Br,	3694.6	11.7	Pt,
	3691.6	12.1	B,	3701.7	11.5	Br.
231425 W PEGASI						
	3669.4	10.9	L,	3695.7	10.1	Lv,
	3671.1	11.0	Ch,	3695.7	10.1	Lv,
	3691.8	9.8	Br,	3706.7	9.5	Lv,
	3693.3	10.4	L,	3709.6	9.4	Hu.
	3695.5	10.1	Gd,			
231508 S PEGASI						
	3678.8	11.9	Br,	3694.6	12.7	Pt.
	3692.7	12.6	Br,			
232848 Z ANDROMEDAE						
	3671.2	9.6	Ch,	3701.8	9.7	Ch.
	3694.6	9.5	Pt.			
233335 ST ANDROMEDAE						
	3671.1	9.4	Ch,	3694.6	9.4	O,
	3674.0	10.2	Nk,	3694.6	8.6	Pt.
	3677.7	9.3	Wf,	3694.7	8.9	Wf,
	3679.7	9.2	Sg,	3696.5	9.1	Pi,
	3685.0	9.0	Nk,	3702.8	9.3	Wf,
	3688.1	9.2	Ch,	3709.6	7.9	Hu.
	3693.7	9.0	Sg,			
233815 R AQUARII						
	3670.1	9.2	Ch,	3699.6	9.2	Ly,
	3670.6	9.1	An,	3694.6	9.1	Pt,
	3674.6	9.2	An,	3695.6	9.0	Ca,
	3682.5	9.2	An,	3708.6	9.1	Ly.
	3693.3	91.	An,			
233956 Z CASSIOPEIAE						
	3677.7	13.6	Wf,	3702.8	13 9	Wf,
	3694.7	13.7	Wf,	3706.8	13.5	Lv.
	3696.8	13.5	Lv,			
235053 RR CASSIOPEIAE						
	3670.2	11.0	Ch,	3694.6	11.4	O.
	3691.6	11.2	B,	3696.5	11.4	Pi.
235209 V CETI						
	3638.0	12.5	Bl,	3692.7	10.8	Br,
	3650.1	11.2	Bl,	3694.3	10.0	L,
	3670.6	10.0	L,	3694.6	9.8	Pt.
235350 R CASSIOPEIAE						
	3678.7	12.2	Br,	3696.8	11.9	Lv,
	3691.6	12.1	B,	3706.8	11.4	Lv.
	3692.8	11.8	Br,			
235525 Z PEGASI						
	3691.8	12.5	Br,	3694.6	13.1	Pt.
235855 Y CASSIOPEIAE						
	3678.8	12.5	Br.			
235939 SV ANDROMEDAE						
	3679.7	12.6	Br,	3696.7	12.8	Lv.
	3694.6	12.6	Pt,			

Total observations: 2510; Stars: 334; Observers: 34.

HOWARD O. EATON, Recording Secretary.

COMET AND ASTEROID NOTES.

New Comet.—A cablegram dated October 24 was received at the Harvard Observatory on October 25 from the Central Bureau of Astronomical Telegrams at Copenhagen, signed by Kobold and Strömgren, announcing the discovery of a new comet by Dubiago at Kasan in the following position:

October 14.5542 G. M. T.
R. A. $7^h\ 46^m\ 42^s.7$
Dec. $-20°\ 37'\ 31''$
Daily motion, $1°\ 40'$ east; $4°\ 51'$ south
Magnitude 8.0

A sceond cablegram received from Professor Strömgren on October 31 gives the following observations from Madrid by M. Arturo Bernard:

October 11,	Right Ascension	$7^h\ 29^m$	, North Polar Distance		99°
" 12,	"	"	$7^h\ 37^m.6$,	" " "	102°
" 15,	"	"	. ..	" " "	115°
" 16,	"	"	. ..	" " "	120°

Harvard College Observatory Bulletin 792.

Elements of Comet *a* 1923 (Dubiago-Bernard).—This new comet appears to have been discovered independently by two observers. The comet has moved rapidly across the southern heavens and is now coming north. Professor Strömgren, of Copenhagen, cables the following rough ephemeris, which indicates that the comet may in December reach the southern parts of the constellation Scorpio.

EPHEMERIS OF COMET *a* 1923.

G.M.T.	R. A.	Dec.	Light
1923 Nov. 9.5	$16^h\ 04^m\ 32^s$	$-64°\ 10'$	0.6
13.5	16 28 20	−61 04	
17.5	16 43 04	−58 05	
21.5	16 52 44	−55 32	0.3

According to the Harvard Bulletin 723 a later cablegram from Copenhagen contains the following elements, which were computed at the Cape of Good Hope:

ELEMENTS

Time of perihelion passage	$T = 1923$ Nov. 16.700 G.M.T.
Perihelion minus node	$\omega = 254°\ 32'$
Longitude of node	$\Omega = 227\ \ 36$
Inclination	$i = 114\ \ 07$
Perihelion distance	$q = 0.7900$

New Comet *b* 1923.—A cablegram, received at Harvard Observatory from the Central Bureau of Astronomical Telegrams at Copenhagen, dated November 8, announces the observation of a cometary object by Reinmuth, of Königstuhl. The wording of the message indicates that it was originally discovered by Crommelin. The magnitude is given as 13.0. The object has been looked for on two nights at Northfield with the 16-inch telescope but was not found.

The following observations have come to hand:

	G.M.T.	R.A.	Dec.	Observer	Place
October	31.3400	$1^h\ 15^m\ 04^s$	$+22°\ 34'\ ''$	Reinmuth	Konigstuhl
November	5.3440	1 17 50.9	+19 47 23	Reinmuth	Königstuhl
	10.6607	1 21 30.4	+16 54 14	Bower	Washington
	13.5843	1 23 56.5	+15 20 26	Bower	Washington

At the last observation the comet was reported to be still of magnitude 13.0.

COMMUNICATIONS.

An Interesting Phenomenon.—The phenomenon I am relating may interest some of the readers of POPULAR ASTRONOMY.

The night of Sunday, Oct. 21, 1923, was cloudy which adds interest to what I saw.

In azimuth 150° and altitude 30°, roughly, I saw as I looked up into the northwestern sky, a red flashing point appear suddenly before my eyes. It resembled Mars at a favorable opposition. Instantly several bright emanations darted out from the sides, being almost as bright as the primary body. These instantly vanished, leaving the sky clear for a moment.

Closely following this there appeared above and to the east, a few degrees, a body similar to the first, which followed the same process of disintegration.

All this took place in a few short seconds. Towards the end I could hear thunderous reports faintly welling up from the north.

SAMUEL CRAMER.

Betelgeuse (α Orionis).—I would like to call the attention of variable star observers to the increase in brightness of α Orionis (Betelgeuse) since last April. During the interval Oct. 29-Nov. 12, it was fully 2/10 of a magnitude brighter than Rigel. Mr. Boss with the selenium photometer states that it is ⅓ brighter than it was a year ago. He is giving Betelgeuse much attention, also α Herculis, α Cassiopeiae and β Pegasi.

FRANK E. SEAGRAVE.

Boston, Nov. 16, 1923.

A Bright Meteor.—Nov. 4th, 8:12 P. M., Pac. S. Time, I saw a meteor appear in Aquarius some 10° N. W. of Fomalhaut, cross the sky 12° W. of Altair and disappear in Lyra 9° N. E. of Vega. When first seen it seemed white and nearly twice the size of Venus at her brightest and gradually increased in size and brilliance until nearing Altair it was one-half to two-thirds the moon's diameter and had a yellow or lemon tinge, and made a plainly perceptible shadow. When crossing the S. W. part of Cygnus it began to disintegrate leaving a trail of 8 or 10 small pieces strung along its path like sparks from a Roman candle. There was no final rupture nor apparent diminution in size; it merely melted away as though entering into dense smoke. The whole duration of flight might be 3 seconds, the latter half of its journey occupying 2 seconds, the lessening speed being quite perceptible.

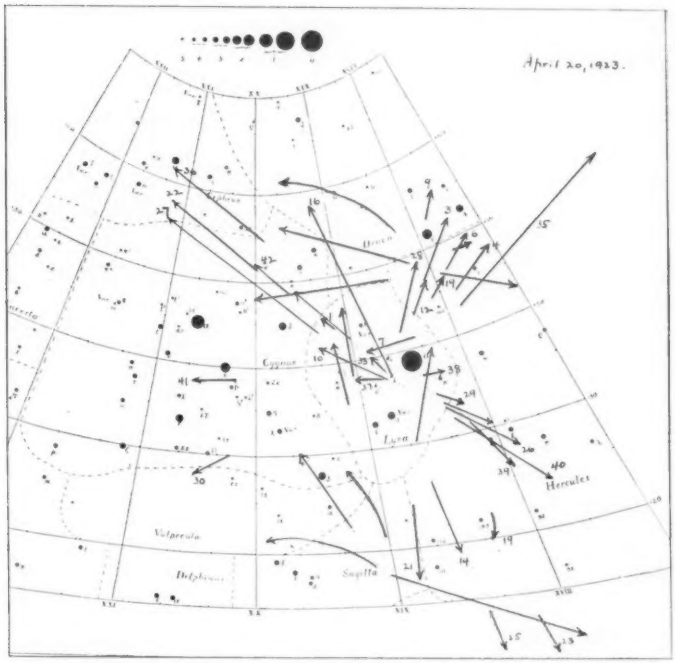
The night was beautifully clear and perfectly still, and I waited nearly two minutes to hear any possible report of an explosion, for I judged the meteor could not be over 20 miles away, but I heard none.

My location was on the Mokelumne river in San Joaquin County, almost

midway between Sacramento and Stockton; and 8 miles W. N. W. from Lodi, and 2 miles S. E. from Thornton on the Western Pacific railway.

JAMES WALLACE.

R. 2, Box 142, Lodi, California, Nov. 5, 1923.

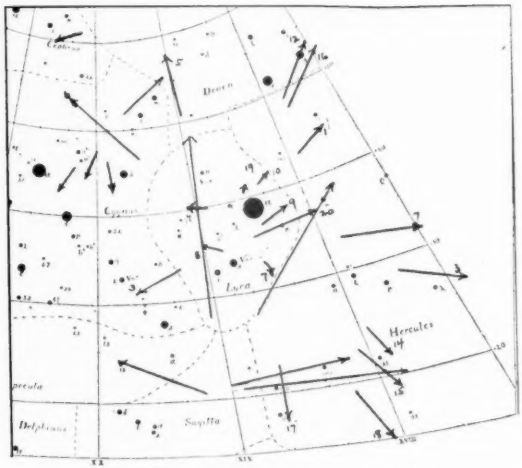


THE LYRID METEORS, APRIL 20, 1923.

The Lyrids, April 18-23, 1923. — April was very cloudy as usual and it was impossible to get three clear nights during the most active time of the Lyrids. They did not seem to be very active this year.

April 18. Clear, bright; 2 seen in a two hours watch.
April 19. Clear, warm ; none seen in two hours.
April 20. Clear, warm ; 43 observed in two hours and ten minutes.
April 21 and 22. Completely overcast.
April 23. Clear, cool; 20 observed in one hour and a half.

	MAGNITUDE							COLORS					
	—0	1	2	3	4	5	6	Total	White	Yellow	Red	Blue	Total
April 18				2	2		1	5	5				5
April 20	1	1	5	8	4	7	17	43	30	8	1	4	43
April 23		1	3	5	3	6	2	20	14	3		3	20
Totals	1	2	8	15	9	13	20	68	49	11	1	7	68

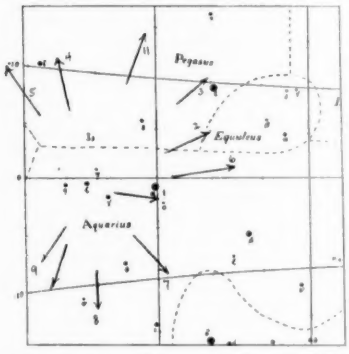


THE LYRID METEORS, APRIL 23, 1923.

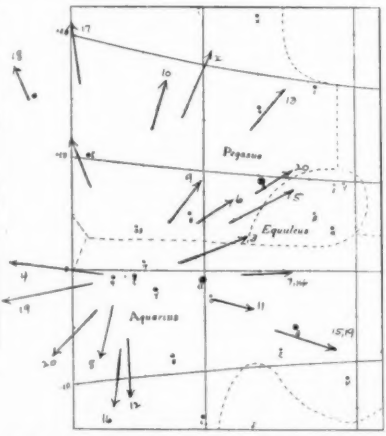
Only one was seen to leave a train; two had curved paths.

		POSITION OF RADIANT.	
April 18	12:45 P. M.	+37°	382°.5
April 25	11:45 P. M.	+35°	282°.0

The Eta Aquarids. — Splendidly clear weather obtained from April 30 to May 8 with the exception of May 7, which was overcast. Watch was kept on seven days; a bright moon interfered, but observation was made from a shaded place with the moon shut out. Faint meteors were not counted, as being uncer-

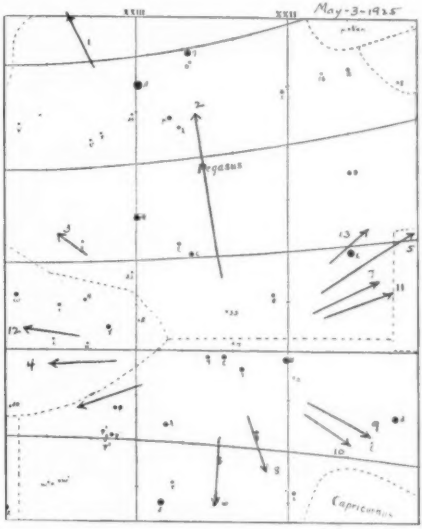


THE AQUARID METEORS, MAY 4, 1923.



THE AQUARID METEORS, MAY 5, 1923.

tain. The Aquarids were unusually active and there were a number of bright ones. The maximum was reached on the 5th; none were seen on April 30 and May 8.



THE AQUARID METEORS, MAY 3, 1923.

					MAGNITUDE							
					—1	0	1	2	3	4	5	6 Total
April	30	Clear, cold;	none	observed								
May	1	Clear, cold;	9	"			1		4	4		9
May	2	" "	11	"			1	3	4	3		11
May	3	" "	13	"			1	2	7	3		13
May	4	" "	11	"			1	3	3	4		11
May	5	" cool;	22	"		1	3	4	8	4	2	22
May	6	" hazy;	14	"			1	3	3	6	1	14
		Total	80	Totals	1		7	15	29	24	3	80

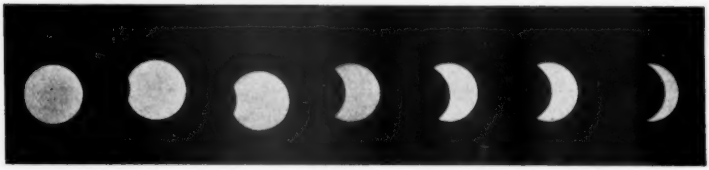
Colors and trains were uncertain in the moonlight.

POSITION OF RADIANT.

May 2	14.8	—1°	335°.3
May 3	14.8	—2°	335°.7
May 4	14.8	—2°	336°.3
May 5	15.0	—2°	336°.9
May 6	14.5	—2°	337°.5

R. M. DOLE.

East Lansing, Michigan.

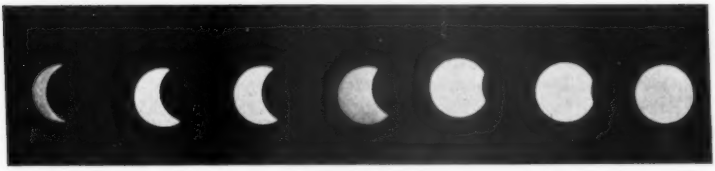


PHOTOGRAPHS OF THE PARTIAL PHASES OF THE ECLIPSE OF SEPT. 10, 1923.
Taken by the Townsend X-Ray Party at Fort Worth, Texas.

An Amateur Eclipse Party.—It was the intention of the writer to make an expedition into Mexico to make pictures of the total eclipse of September 10 at the line of totality, and all arrangements had been made to that end. On the eve of our departure, however, we received information that an epidemic of

THE TOWNSEND X-RAY ECLIPSE STATION.

smallpox and yellow fever had broken out in Mexico, and that there would probably be danger of a quarantine upon our return to the border. We had made arrangements for a short period of time only, and our business would not allow of a risk of delay upon our return. We therefore abandoned the expedition much to our disappointment. Since all of our instruments were ready, we decided to make such pictures of the eclipse as possible at our home station. To note also the times of contacts as accurately as possible. Our photographic equipment consisted of a plateholder, with shutter attached, placed in the primary focus of



PHOTOGRAPHS OF THE PARTIAL PHASES OF THE ECLIPSE OF SEPT. 10, 1923.
Taken by the Townsend X-Ray Party at Fort Worth, Texas.

a four-inch Clark telescope, the objective stopped down to 1½ inches covered by a K,3 and K,1 Filter. In addition to this we had a 27-inch Willard Portrait lens fitted with plateholder and shutter; this camera was likewise fitted with filters, and the exposure in every case was as fast as the shutter would operate, something like 1/25 of a second. For the timing of the contacts we had a Waltham chronometer regulated by observation, and also checked with telegraph time. This chronometer was rated to Astronomical Mean Time for this particular work. For the benefit of the person who noted the contacts through a three-inch instrument, and in lieu of a chronograph, we had a telegraph sounder connected in series with the pendulum of a sidereal clock fitted with a mercury break, beating seconds. Weather conditions at our station were perfect, in exasperating contrast with the clouds which we understand prevailed on the Pacific Coast, and in some parts of Mexico. Below are given the contacts together with the position of our station.

Longitude of station	97° 15′ 12″
Latitude of station	32 44 15
First Contact	1^h 46^m 34^s
Last Contact	4 14 58

Contacts of the moon's limb with the sunspot which was visible were noted but an inaccuracy in the time was made, and so this is not included.

The illustrations show our instruments at our station. The sun pictures are those made at the primary focus of the four-inch Clark instrument. The plates made with the large Willard lens were good, but of such small diameter that they are not shown here. The eclipse pictures are of the original size, not being enlarged. The writer was assisted by Mr. Bunch in carrying out the above set of observations.

TOWNSEND X-RAY.

GENERAL NOTES

Rev. John T. Hedrick S. J. died October 24, 1923, in his 71st year at St. Andrews-on-Hudson, near Poughkeepsie, N. Y. He was born in Georgetown, D. C., on May 6, 1853. In his early life he was first a computer under Newcomb, and then an assistant astronomer for four years under Gould in Cordoba, Argentina. After teaching mathematics for about nine years in Woodstock College, near Baltimore, he was for a long time at the Georgetown College Observatory under Father Hagen, whom he succeeded in the directorship in 1906. Failing health, however, soon obliged him to retire to St. Andrews, where he served as treasurer until a few months before his death.

He was a rapid and elegant computer and seldom made mistakes. He was a severe critic, not only towards others, but also towards himself, so that he could only rarely induce himself to put matters in print. This was the case notably with his photographic observations of the variation of latitude. Over 2000 plates were taken and measured, but owing to the unsatisfactory behavior of the four levels used, the results have never been published. Ill health and the want of the necessary assistance also precluded all work with the photographic transit, with which he had intended to form a new catalogue of stars absolutely devoid of all personal equation. He had likewise begun a general catalogue in which references were given to all other catalogues, a project that was evidently too great for one man, and was later on commenced more successfully in Germany by an association.

Mr. James B. McDowell, head of the McDowell Company in Pittsburgh, died at his home on November 28.

He was born in Pittsburgh in 1861 and after serving an apprenticeship in one of the large glass factories of that city he joined the then recently formed John A. Brashear Company. He soon showed extraordinary ability in the handling of optical surfaces and he is personally responsible for all the larger optical work turned out by this company. This work includes the following refractors: 20-inch (Oakland), 24-inch (Swarthmore), 26-inch (Yale), and 30-inch (Allegheny). The following reflectors were also figured by him: 30-inch (Allegheny), 37-inch (Chile), 37-inch (Ann Arbor), 36-inch (Tucson), and 72-inch (Victoria).

Mr. McDowell is survived by his widow, who was the adopted daughter of Dr. and Mrs. John A. Brashear. Two sons were born to them, but both of them died a few years ago.

Request to Members of the A. A. V. S. O.—It is requested that all members of the A. A. V. S. O., who have been kind enough to record the telescopic meteors seen by them during 1923, will send in their observations for the year to the undersigned by Dec. 31. It is believed that with those observations made this year enough have perhaps been collected to permit the first comprehensive report on the subject to be made.

CHAS. P. OLIVIER.

Leander McCormick Observatory, University of Virginia.
1923, November 15.

The Tokyo Observatory and the Earthquake.—The following letter from Professor S. Hirayama, director of the Tokyo Observatory, was received in November by Mr. Issei Yamamoto, who was then at the Harvard College Observatory. The letter was translated into English by Mr. Yamamoto and communicated to us so that the readers of POPULAR ASTRONOMY might have first hand information as to the effect of the great earthquake upon the Tokyo Observatory. As indicated in the letter the observatory was at the time in process of removal to a new site.

TOKYO, OCTOBER 15, 1923.

DEAR FRIEND:

Many thanks for your kind letter about our condition after the earthquake and fire. Please give my kind regards to Professor Frost and also to Professor

Shapley, who was very kind to me at the Rome meeting and at the Harvard Observatory where I saw him at another time.

At the time of the earthquake, fires broke out as you know and threatened us on two sides: one from Tora-no-mon to Kanaya-cho and the other from Reinanzaka upward, so that the observatory seemed sure to be burned, but fortunately escaped by a narrow margin. During the critical time the interiors of the buildings were in such disorder from the scattering of books, shelves, and window glass that nobody could enter them. The yard was thickly crowded with refugees and the dwelling houses of the staff were tilting or crushed, so that everything was beyond description.

The main building lost its whole roof, the tile being all shaken down, so that every room became wide open to the sky. Clocks were practically all destroyed, some were entirely broken down because of the falling of the stone pillars on which they were hanging and others lost their pendulums by the breaking of the suspension springs. The Riefler clocks suffered relatively less damage and were afterward repaired, but their daily rates are not constant up to this time, and it is quite doubtful whether they will recover their former accuracy.

The Repsold Meridian Circle fell to the floor and cannot be used again. Two Bamberg Transit Instruments, which were being used at the time in observing the difference of longitude between the present and the new observatories, were both thrown down from the piers and cannot be repaired. The Zenith Telescope, with which you were familiar at Mizusawa, was damaged while actually in use at the new observatory, where the latitude was being observed with it; the micrometer and levels were broken in pieces. Almost all of the foundations of the equatorial telescopes and clocks were damaged!

The eight-inch equatorial, which had been dismounted for the purpose of removing to the new observatory, luckily escaped injury. It was most fortunate that the books were saved because we escaped the fatal fire.

The Department of Education of the Government was completely burned out, and consequently everything belonging to the National Geodetic Association was lost. (Signed) S. HIRAYAMA.

Note on Density of Stars in Space. – An estimate can now be made of the number of stars of certain spectral classes in a given volume of space, using data derived from the Henry Draper Catalogue and from current investigations of the average absolute magnitudes of the different classes. The statistics of stars brighter than visual magnitude 8.25, as collected in Harvard Circular 240 for the Milky Way and summarized in Circular 248 (in press), have been made the basis of the computation by the writer of the stellar frequencies given below. Since the average early B star is at a distance of about one thousand parsecs, when apparently as faint as 8.2, it is best, for this preliminary computation, to restrict ourselves to low galactic latitudes in order that no allowance need be made for the change of average stellar density with distance.

In the following tabulation, the first column gives the spectral division, the second, the spectral classes within each division, and the third gives the average number of stars brighter than visual magnitude 8.25 in one hundred square degrees. These averages are based on counts for 2300 square degrees in all longitudes along the central line of the Milky Way.

The fourth column gives the distance in parsecs throughout which the stars of each type have been collected. The limiting distances are computed from adopted mean absolute magnitudes, such as those given in Circular 243. The B, A, K, and M stars in the Henry Draper Catalogue are, almost without exception, giants, and the space from which they are enumerated is therefore conspicuously greater than for the F and G stars, which are predominatingly dwarfs. For example, the space throughout which the B stars of this investigation lie is about 1.5×10^8 cubic parsecs and is two thousand times as great as that for the dwarf G stars.

Division	Spectral Classes	Surface Number	Distance Limit	Space Number
B	B0 — B5	29.7	880	4.4
A	B8 — A3	96.9	340	250
F	A5 — F2	18.7	140	680
G	F5 — G0	26.0	70	7600
Giant K	G5 — K2	69.0	350	160
Giant M	K5 — Mc	17.5	430	22

The values in the last column are the numbers of stars in a million cubic parsecs. On account of the amount of material involved in these counts, it is not probable that local aggregations have seriously affected the results. The tabulation does not take account of the Cepheids, the giants of Class G, the abnormally faint A stars, nor the dwarf K and M stars. Stars of these last two classes are probably much more numerous per unit volume than dwarf stars of Class G. As a first approximation, the giant G stars may be taken as one-half as numerous as the giants of Class M.

Perhaps the most interesting deduction from these results is that for every Class B star that is in the stage of development represented by the stars in the Orion and Scorpius clusters, there are about five giant M stars and seventeen hundred dwarf stars like our Sun. This conclusion should be of some significance in considerations of stellar evolution.

Harvard College Observatory Bulletin 792.

The Thirty-First Meeting of the American Astronomical Society.

The following is taken from the Circular of Information issued by Secretary Joel Stebbins, director of the Washburn Observatory, Madison, Wisconsin.

On the invitation of Miss Caroline E. Furness, director of the Vassar Observatory, the thirty-first meeting of the Society will be held at Vassar College, Poughkeepsie, N. Y., from December 27 to 29, 1923.

Poughkeepsie is about half-way between New York and Albany, on the main line of the New York Central Railroad, and most of the express trains stop there. The College is about three miles from the station but can be reached easily by trolley, as the street cars run direct from the station to the main entrance of the College. Taxis can be obtained at the entrance to the station, fare $1.00. Baggage transfer can be arranged for at the booth on the main floor of the station. The trains stop on a lower level, while the waiting room, offices, etc., are on the upper level.

The Society will be entertained in the Main Building, very close to the main entrance of the College. Any who happen to arrive at an unusually late hour may find a hotel in town, two miles distant from the College. Among others is the Nelson House, rate $4.50 per day, American plan. The evening train leaving New York at eight reaches Poughkeepsie by ten, and members can reach the College before eleven. The night watchman will have the list, and can show people to their rooms, but the reception committee will probably not disband on Wednesday evening until long after ten, the usual hour for the locking of buildings.

There will be a fixed price for each item of entertainment, but members can pay for all at once. Room, $1.25; breakfast, 75c; luncheon, $1.00; dinner, $1.25. Supper will be provided at six o'clock prompt on Wednesday, December 26, and the dormitory will be open on that evening.

Mail should be addressed care of the American Astronomical Society, Vassar College, Poughkeepsie, N. Y.

There will be a minimum of outside entertainment and other distraction at this meeting, and formal dress will be unnecessary. The only excursions planned are for those who may wish to drive about the country to look for sites for the solar eclipse of January, 1925. The afternoon sessions have been placed at a late hour to give plenty of time for such reconnaissance by daylight.

PROGRAM
(Subject to change)

Wednesday, December 26, 1923

8:00 P. M. Meeting of the Council at the Observatory.

Thursday, December 27

10:00 A. M. Opening session for papers, Lecture Room, Sanders Laboratory of Chemistry.
3:30 P. M. Session for papers.

Friday, December 28

9:00 A. M. Meeting of the Council.
10:00 A. M. Session for papers.
3:30 P. M. Session for papers.

Saturday, December 29

9:00 A. M. Meeting of the Council.
10:00 A. M. Session for papers.

VY Pegasi (27.1920).—The variable star VY Pegasi is not seen on photographs made at Harvard in July of this year, which show stars fainter than magnitude 15.4. It appears to resemble the peculiar novae that have a long duration of maximum light; or perhaps it is more comparable with H. D. 81137 (H. B. 783), which first slowly increased in brightness for at least eleven years, and then faded gradually and slightly for the next twenty years. At any rate, the star no longer compares closely with RT Serpentis, which came up thirteen years ago and remains at constant brightness (H. B. 789).

VY Pegasi appeared in 1908 (*Cf.* H. B. 759), and reached a maximum photographic magnitude of 11 in 1920, according to Wolf (A. N. 5069). A steady decrease from magnitude 12 to 14.4 was observed during October, November, and December of last year by Graff (A. N. 5245).

The spectrum of the star is unknown; its galactic latitude is $-41°$.

Harvard College Observatory Bulletin 792.

Omicron Ceti a Double Star.—A letter received from Professor Robert G. Aitken, associate director of the Lick Observatory, states that he observed o Ceti on October 19, by request of Professor Alfred H. Joy of the Mount Wilson Observatory, and found that the star is a visual double. The companion is apparently bluish in color and fully half a magnitude fainter than the variable star; it is 1".01 distant, in position angle 132°.3. Professor Aitken adds that earlier examination by himself and by Doolittle in January, 1903, and December, 1905, respectively, gave no evidences of a companion, and that possibly the separation has increased.

On the basis of peculiarities in the spectrum, as described at the Twenty-ninth Meeting of the American Astronomical Society (*Cf.* Pop. Ast. **31**, p. 237, 1923), Joy had previously suggested that o Ceti might be a binary, composed of the variable, with spectrum changing from M6e to M9e, and a faint star having an early type spectrum with strong emission bands of hydrogen and helium.

He estimated the distance and position angle at 0".3 and 135°, respectively. Professor Barnard had examined the star at minimum in the preceding year but found no evidence of a second component.

The observations available at Harvard from the members of the Variable Star Association show that the magnitude of *o* Ceti on October 19 of this year was 9.2. Since the parallax of *o* Ceti appears to be about 0".04 ± 0".02, the corresponding absolute magnitude of the two components combined was of the order of +7 on October 19.

Harvard College Observatory Bulletin 792.

To Observe an Occultation with a Movie Camera. — Clouds on the evening of Nov. 23 defeated our attempt to observe the occultation of Aldebaran with a movie camera.

The apparatus was that which we had prepared for use at the eclipse on Catalina Island and consisted of a Universal camera, kindly loaned us by Dr. George S. Isham. This was mounted in a light-tight wooden box on a tripod carrying a 4-inch telescope, which was also the property of Dr. Isham. The lens employed was a Hawkeye of aperture 3⅛ inches and focal length 20 inches, which had originally been loaned to us for the eclipse by the Eastman Kodak Company through the kind interest of Mr. C. W. Frederick. We were allowed to retain this longer for these experiments. This was firmly attached to the other end of the box and gave an image of the moon 3.5 mm in diameter. An electric lamp of ½ watt was so placed in the box that a black dot would be impressed on the edge of the film at every second from the circuit of the Howard sidereal clock.

The red color of Aldebaran made it necessary for us to give a longer exposure than would be the case for a whiter star of corresponding magnitude, and preliminary exposures by Mr. Struve, assisted by Mr. Ridell, with films of par-speed, indicated that fully a quarter of a second would be required for a good impression of the star's image. I accordingly secured super-speed film, as it was desirable to get five or six exposures to the second. There is still an uncertainty on the question of the shortest exposure possible.

As there will be four occultations of Aldebaran and one of Regulus, visible in this country during the coming year, we shall hope to succeed in testing out this method of observing phenomena of this character.

EDWIN B. FROST.

Yerkes Observatory, November 26, 1923.

Orbit of the Spectroscopic Binary Boss 2463. — In the *Publications of the Dominion Astrophysical Observatory*, Vol. II, No. 11, Dr. R. K. Young gives the results of measures of 24 spectrograms of the star Boss 2463 ($1900\,\alpha = 9^h\,06^m.4$, $\delta = +61°\,50'$, mag. 5.2, type F8). The star is a dwarf of very low absolute magnitude. The final elements obtained for its orbit are

P	= 16.2382 days	± .0010 days
e	= 0.09	± .021
ω	= 169°.25	±7°.5
γ	= −14.99 km	± .32 km
K	= 34.78 km	± .41 km
T	= J.D. 2,423,049.617	± .320 days

$$\frac{m_1^3 \sin^3 i}{(m + m_1)^2} = 0.07\,\odot$$

Eleven New Southern Variable Stars.—On photographs made during the last two years with the Bruce telescope at Arequipa, Professor Bailey has discovered the following faint variable stars, most of which appear to have long periods.

Harvard Variable	R. A. 1900 h m	Dec. 1900 ° ′	Maximum Magnitude	Minimum Magnitude	Probable Period d
3689	12 49.9	—69 30	14.7	18.0	255
3690	12 45.8	—71 15	14.0	18.0	260
3691	12 47.6	—71 40	14.5	18.0	129
3692	12 52.0	—70 12	15.5	16.5	Short
3693	12 54.2	—70 26	13.5	17.5	360
3694	13 1.2	—70 41	15.0	[18.5	235
3695	13 1.8	—70 44	14.0	16.0	Short
3696	13 2.0	—69 33	13.5	17.5	151
3697	13 4.1	—69 53	14.0	18.5	170
3698	13 5.9	—70 35	13.5	18.5	200
3699	13 8.0	—70 23	16.0	[18.0	?

All these new variables are within ninety minutes of arc of the globular cluster N. G. C. 4833 (galactic latitude —8°), but it is quite possible that few, if any, of them are physical members of that stellar system. The periods of Nos. 3689, 3690, and 3693 may be one half the values given in the last column. No. 3699 is at maximum light on all but two plates. The limiting magnitudes are provisional.

Harvard College Observatory Bulletin 792.

Radcliffe Stellar Parallaxes.—Volume LIII of the publications of the Radcliffe Observatory, Oxford, England, contains the results obtained in the determinations of stellar parallaxes from photographs taken with the 24-inch refractor, under the direction of Arthur A. Rambaut. Quite full descriptions are given of the telescope and measuring apparatus and of the plan of the observations.

Nine regions were photographed according to Kapteyn's plan or a modification of that plan, in which each plate was given 4 sets of triple exposures, two near each phase of maximum parallax. At first the four sets of triple exposures were made upon a single plate, but in 1906 this plan was modified so that the first two sets were made on one plate and the last two on a second plate. The latter plan was found on the whole to be more satisfactory, involving, among other things, less risk of loss by clouds.

In the nine regions the parallaxes of 2408 stars were determined. The stars range in brightness from about 7.0 to 12.5 mganitude. From the smoothed means of all the groups Dr. Rambaut finds the following values of parallax, arranged according to the brightness of the stars:

Magnitude	7.0	8.0	9.0	10.0	11.0	12.0	12.5
Parallax	+0″.024	+0″.018	+0″.012	+0″.007	+0″.002	—0″.002	—0″.004

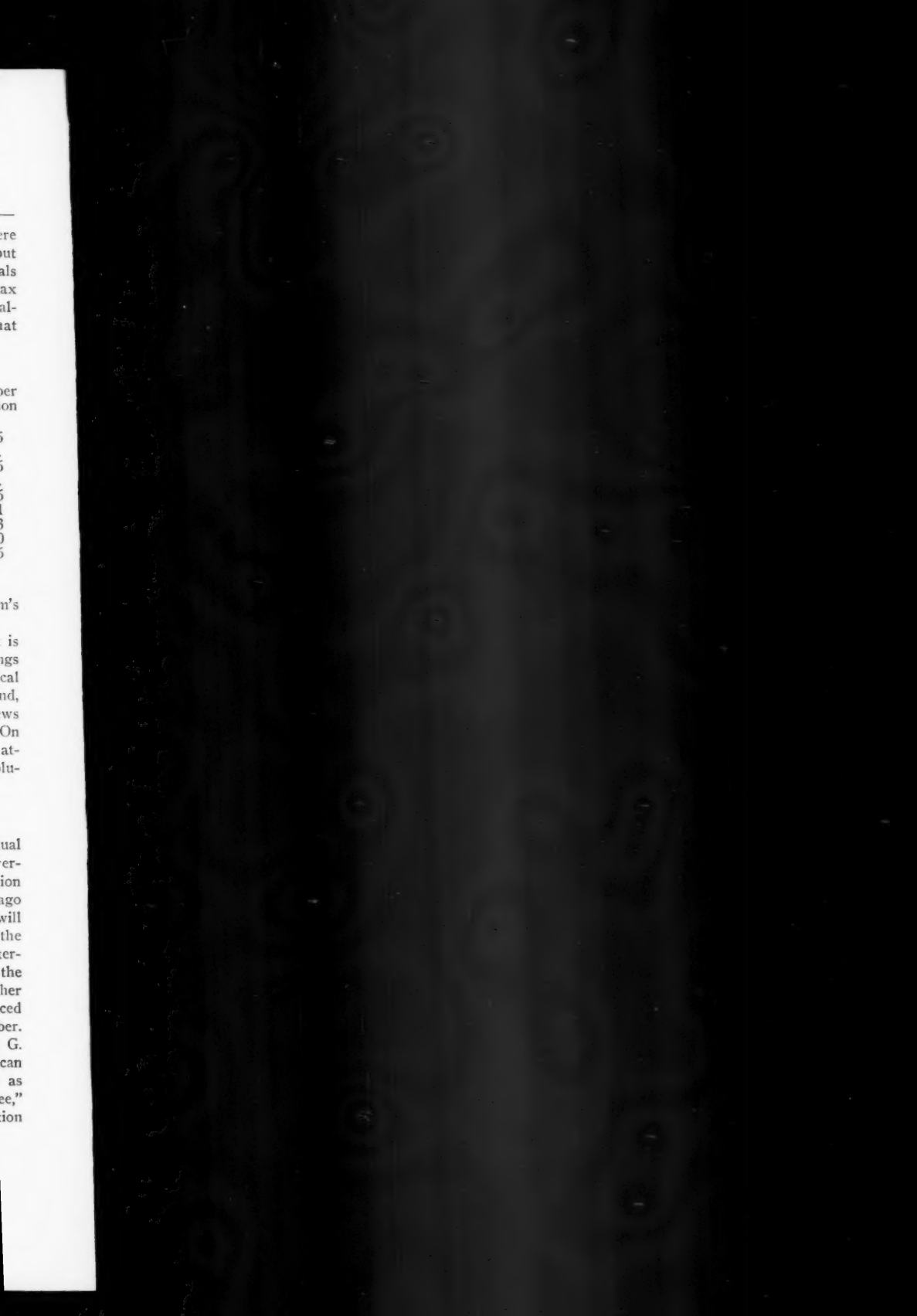
The systematic corrections to the parallaxes derived from separate plates, depending upon magnitude of the stars, were in most instances several times as large as the above mean parallaxes, and were applied sometimes with the + and sometimes with the — sign. This of course, only emphasizes the uncertainty of parallaxes, especially of faint stars, determined by wholesale methods, where there is no means of equalizing the apparent brightness of the stars to be compared. In general the parallaxes found for faint stars (of magnitude 10 to 13)

are smaller than their probable errors. One might expect to find here and there a really small star (one faint because of its small size instead of its distance) but these seem to be very rare. A hasty glance over this list of 2408 stars reveals one star of magnitude 11.5 for which 5 plates in good agreement give a parallax of $+0''.062 \pm .011$. For one other star of magnitude 12.4 three plates give parallax $0''.071 \pm .014$. These comparatively near stars are, however, so far away that it takes over 450 years for the light to travel from them to us.

The following is a list of the nine regions studied by Dr. Rambaut:

Group No.	Name of Central Star	Photographic Magnitude	R.A. 1900.0 h	m	s	Decl. 1900.0 °	′	Proper Motion ″
1	BD. +25°495	7.7	3	02	32	+25	58.2	0.86
2	Nova Persei	Var.	3	24	24	+43	33.7	....
3	BD. +41°750 (Σ443)	8.7,9.3	3	40	12	+41	09.0	1.36
4	BD. +15°651 (Hyades)	8.3	4	28	53	+15	17.8	....
5	BD. +51°1094	8.2	5	30	24	+51	22.8	0.56
6	BD. +44°1408	8.9	6	09	33	+44	44.8	0.41
7	BD. +40°1758	9.5	6	49	30	+40	12.8	0.43
8	BD. +48°1469	8.4	6	54	00	+48	31.8	0.70
9	BD. +31°1684	8.3	7	47	10	+30	54.8	1.96

The Wonders of the Stars. — By Joseph McCabe; G. P. Putnam's Sons, New York and London, publishers. $1.75.

This is a small book of 134 pages, which can be read in a few hours. It is written by a popular lecturer, who has, perhaps for the sake of making things interesting to the average reader, sacrificed accuracy of statement and logical order. This may be very well for a lecturer who makes his statements off hand, but not so allowable for one who writes a book, even though scientific views change so rapidly that one must be "up to the minute" to keep track of them. On the whole the book is interesting and worth reading because the author has attempted to put the latest theories of the structure of the universe and the evolution of the heavenly bodies into untechnical language.

The Mathematical Association of America. — The eighth annual meeting of the Mathematical Association of America will be held at the University of Cincinnati, on Thursday and Friday, December 27-28, 1923, in affiliation with the American Association for the Advancement of Science, and the Chicago Section of the American Mathematical Society. On Friday afternoon there will be a joint session of the organizations, and on Friday evening there will be the usual joint dinner. At the first session of the Association on Thursday afternoon, President Carmichael will deliver his presidential retiring address on the "Present state of the difference calculu. and its prospect for the future." Other papers for this session and for the session on Friday morning will be announced in the full program which will be sent to members as usual early in December. At the joint session on Friday afternoon there will be addresses by Professor G. A. Miller as retiring chairman of Section A of the A. A. A. S. on "American mathematics during three-quarters of a centruy," by Professor A. B. Coble as retiring chairman of the Chicago Section "On the equation of the eighth degree," and by Professor L. E. Dickson on "Algebras and their arithmetics," by invitation of the Mathematical Association and of the Chicago Section.